

Alpha Magnetic Spectrometer 02 (AMS-02) Test Plan for the Static Test of the Passive Payload Attach System (PAS)

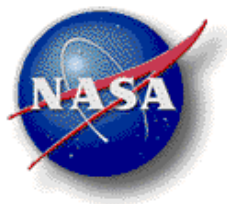
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Test Plan for the AMS-02 PAS Static Test

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ACRONYMS AND ABBREVIATIONS

AMS	Alpha Magnetic Spectrometer
APAS	Active Payload Attach System
CAS	Common Attach Site
EVA	Extravehicular Activity
FEM	Finite Element Model
ISS	International Space Station
JSC	Johnson Space Center
KSC	Kennedy Space Center
LMSO	Lockheed Martin Space Operations
MFL	Maximum Flight Load
PAS	Payload Attach System
P/N	Part Number
QA	Quality Assurance
SSP	Space Station Program
STL	Structural Testing Laboratory
TPS	Task Performance Sheet
TRR	Test Readiness Review
USS	Unique Support Structure

1.0 Test Objectives

- 1.1. Measure the stiffness of the passive PAS system to correlate the FEM.
- 1.2. Demonstrate the function of the EVA-unloadable/releasable capture bar.
- 1.3. Verify procedures that will be used for an Interface Verification Test with the S3 zenith inboard CAS at KSC.

2.0 Overview

The AMS-02 Passive PAS Assembly is a passive structure that will allow the AMS-02 payload to interface with the S3 zenith inboard CAS on the ISS. It consists of three guide pins and an EVA releasable capture bar that is mounted to a frame structure and is shown in Figure 2-1. The active half composed of guide vanes and capture latch is attached to the ISS.

Calculation based on Boeing provided analysis and data shows the overall system is in series and should result in a combined maximum stiffness of 24864 lbf/in, combined nominal stiffness of 22,955 lbf/in, and a combined minimum stiffness of 20,988 lbf/in. The Boeing analysis is in appendix A. The stiffness of the active half based on Boeing data is 46,858 lbf/in and the stiffness of the capture latch based on Boeing data is 45,000 lbf/in.

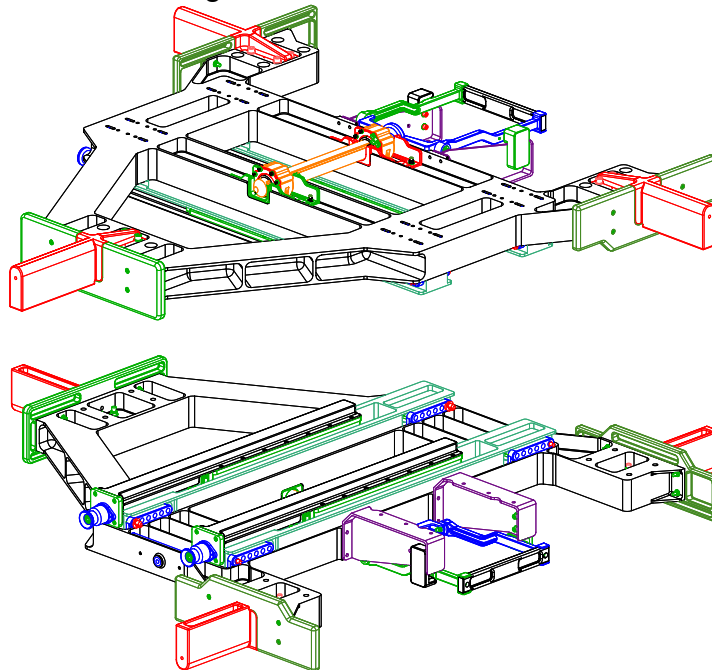


Figure 2-1: AMS-02 Passive PAS Assembly

3.0 Test Hardware

The test hardware is shown in Figure 3-1 and 3-2. The hardware will be provided by the AMS-02 project, except where noted. It will simulate all mechanical interface locations of the active PAS on the ISS. The test article is the Flight AMS-02 Passive PAS Assembly shown in Figure 2-1. The active PAS simulator is shown in Figure 3-2. This simulator will be tested during the static PAS test in order to determine its stiffness. If necessary, the simulator stiffness can be adjusted to match the Flight active PAS. In order to determine the stiffness of the AMS-02 Passive PAS Assembly, a Lower USS Simulator Assembly is required. The simulator is attached to the AMS-02 Passive PAS Assembly. The Lower USS Simulator Assembly is shown in Figure 3-3 attached to the AMS-02 Passive PAS Assembly.

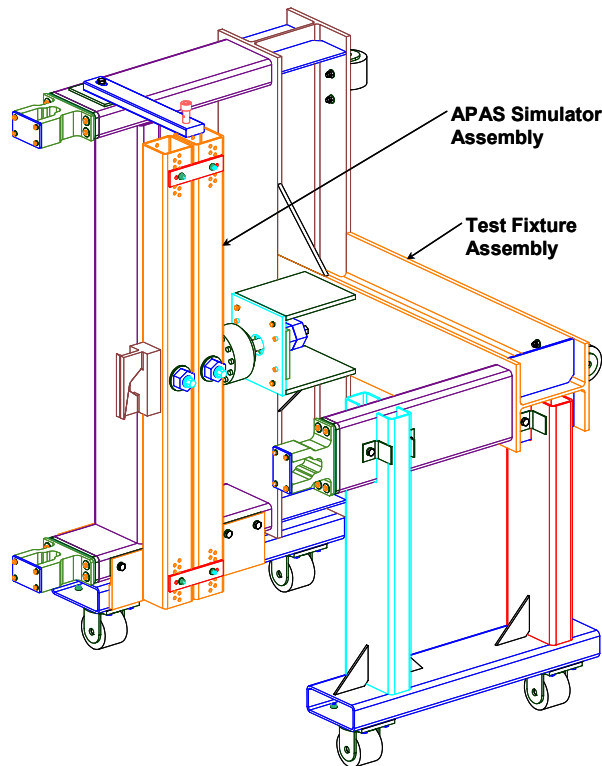


Figure 3-1: Test Hardware

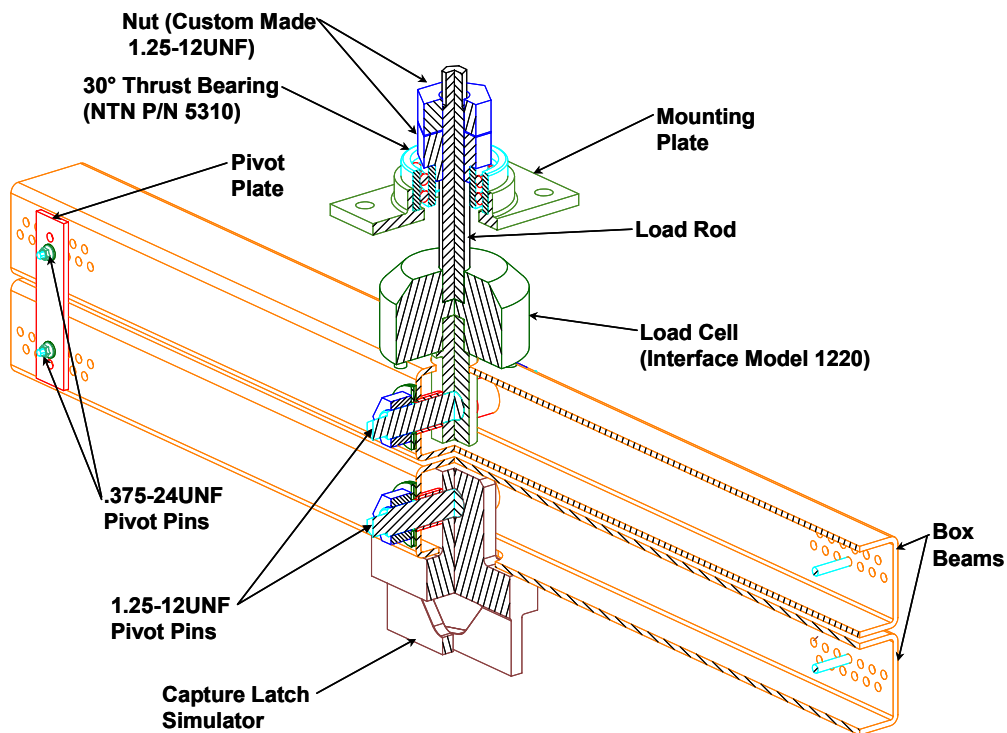


Figure 3-2: Active PAS Simulator Assembly

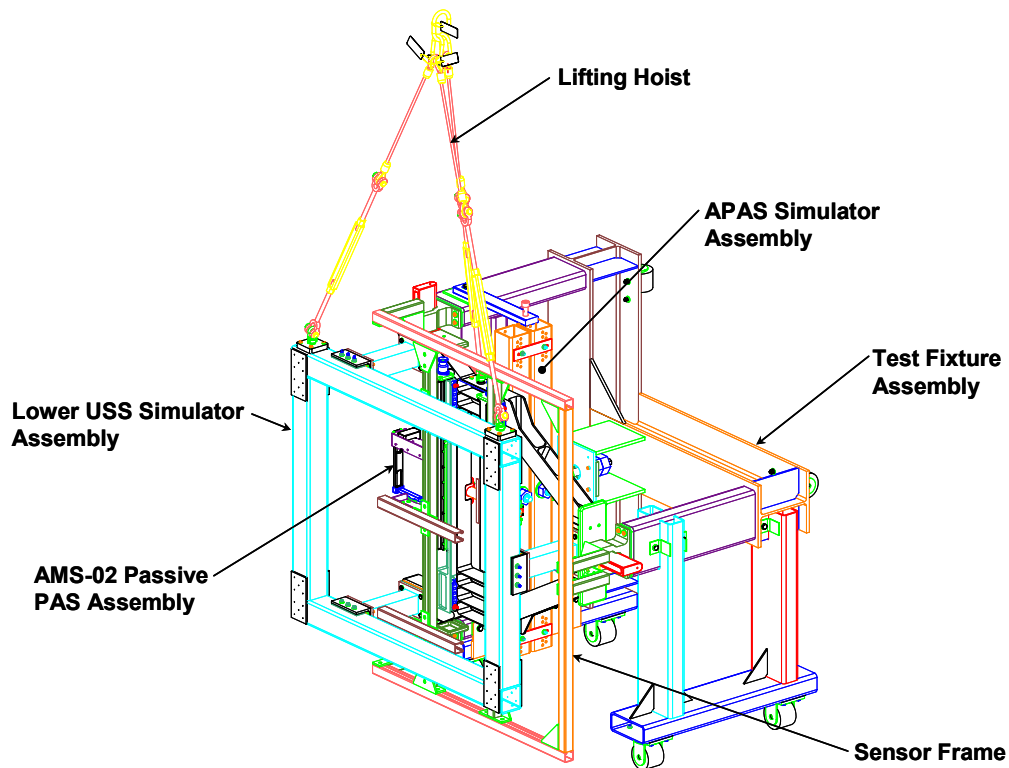


Figure 3-3: Test Setup

4.0 Test Setup

- 4.1. Position the Test Fixture Assembly, P/N SEG36144426-301 in the upright position as shown in Figure 4.1-1.

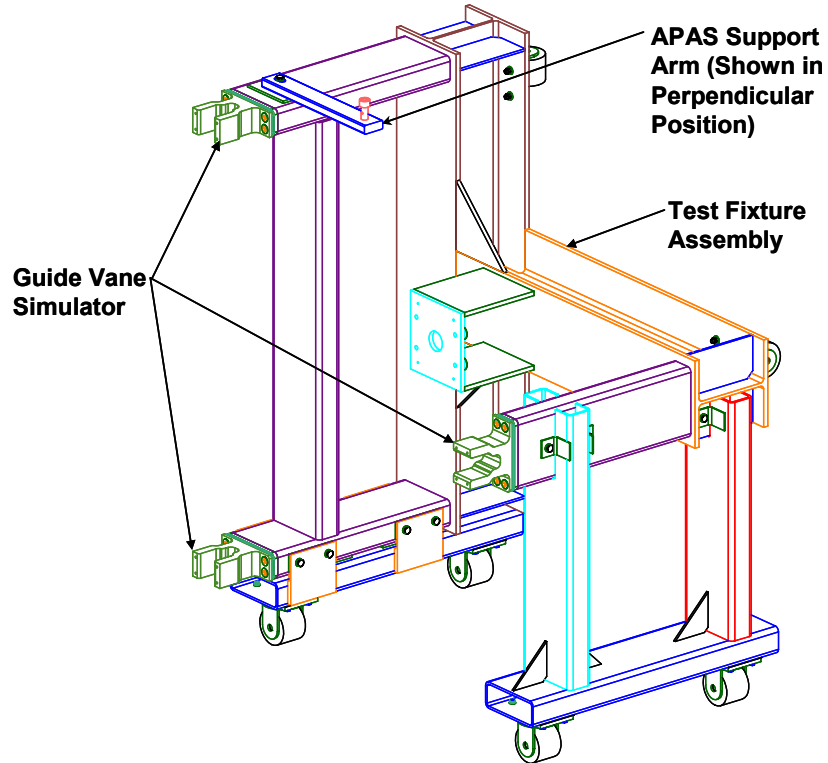


Figure 4.1-1: Test Fixture Assembly

- 4.2. Rotate the APAS Support Arm, P/N SDG36144439-001, so it is parallel to the tube that the arm is fastened to. Torque the fastener that secures the APAS Support Arm to the Test Fixture, P/N SEG36144426-301, hand tight. See Figure 4.1-1 to identify the APAS Support Arm.
- 4.3. Measure the Test Fixture Assembly, P/N SEG36144426-301, with a 24-inch level. If the level indicates that the Test Fixture Assembly is uneven, use Caster Shim, P/N SDG36144438-005, to adjust the Test Fixture Assembly by peeling the required number of layers and placing the remaining shim under each caster. Label the shim and the caster with a black sharpie to prevent misplacement of shims if the Test Fixture Assembly has to be moved. Re-level the Test Fixture Assembly if moved.
- 4.4. Lock the brakes for the wheels and the swivel on the Caster, P/N 2432T74+2432T99, to prevent any movement.

- 4.5. Lift the Lower USS Simulator Assembly, P/N SEG36144421-301, from the shipping crate per lift plan for Lower USS Simulator Assembly, P/N SEG36144421-301, in appendix B.
- 4.6. Position the Lower USS Simulator Assembly, P/N SEG36144421-301, so that the base of the three USS Simulator Bracket Assembly, P/N SEG36144425-301, is pointing up. Place the Lower USS Simulator Assembly on a table or platform that is at least 10 inches above the floor. Position the side of the Lower USS Simulator Assembly that does not have attachment pads for lifting hoists no more than 5 inches from the edge of the table or platform. See Figure 4.6-1.

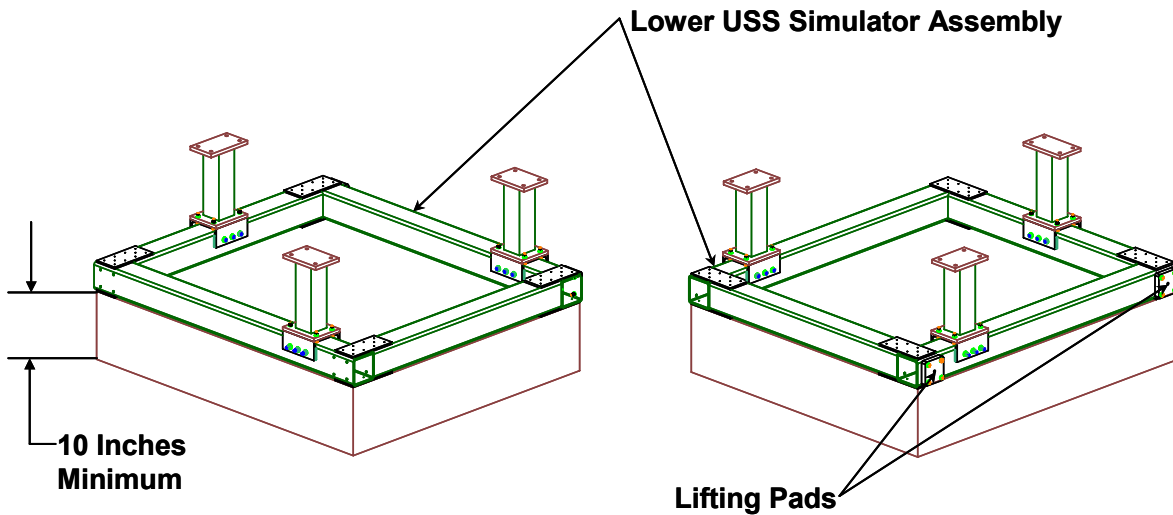


Figure 4.6-1: Lower USS Simulator Orientation

- 4.7. Place a Shim, P/N SDG36144438-007 and -009, on top of each of the USS Simulator Bracket Assembly, P/N SEG36144425-301 and -303. Match the hole patterns on each of the shims to each of the brackets. Use Kapton tape to secure the shims to the brackets. Mark on the surface of the brackets and the shims with a black sharpie to avoid mismatch at a later point in time. See Figure 4.7-1

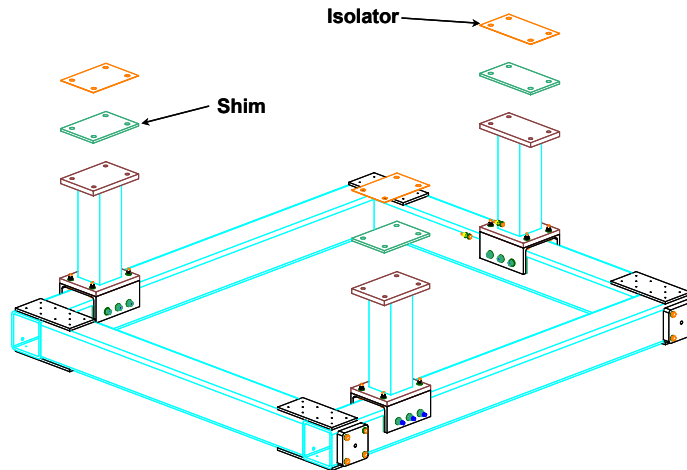


Figure 4.7-1: USS Simulator Bracket Assembly Shims and Isolators

- 4.8. Place an Isolator, P/N SDG36144438-011 and -013, on top of each of the Shim, P/N SDG36144438-007 and -009. Match the hole patterns on each of the isolators to each of the shims. See Figure 4.7-1
- 4.9. Install the Lifting Plate, P/N SDG36144432-001, to the AMS-02 Passive PAS Assembly, P/N SEG39135815-301. The boss on the Lifting Plate fits in the through hole on the sidewall of the AMS-02 Passive PAS Assembly. Secure the Lifting Plate with 2 NAS1003-9 .190-32UNJF-3A X 1.043 long hex head bolt and 2 .190-32UNJF-3B hex nut. The torque values are 34 to 41 in-lbs. Running/locking torque is 2-18 in-lbs. See Figure 4.9-1.

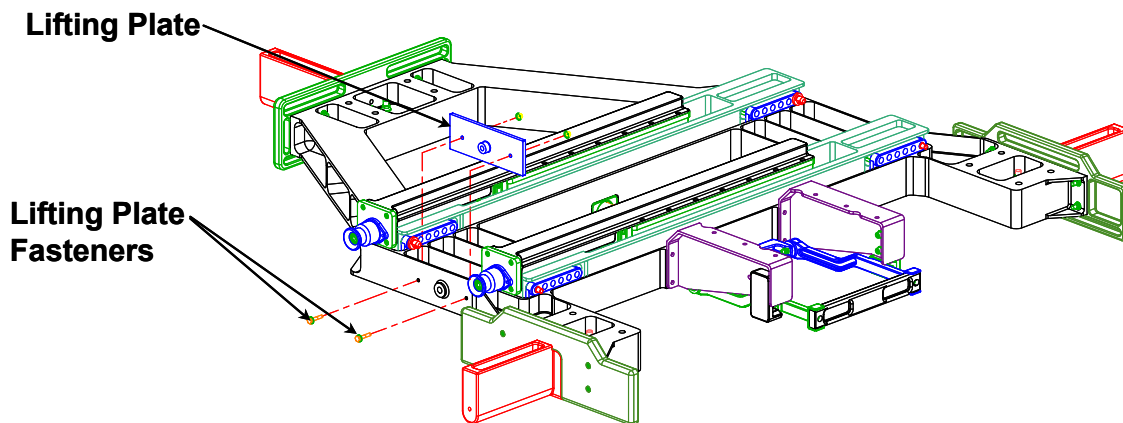


Figure 4.9-1: Lifting Plate Installation

- 4.10. Label the pin hole identification on the Vertex and Rear Bridge Assembly of the AMS-02 Passive PAS Assembly, P/N SEG39135815-301. Place a piece of Kapton Tape on the Bridge Assembly near the holes. Using a sharpie label the pin hole ID per figure 4.10-1. Repeat for all four hole sets. The distance between each hole location is $\frac{1}{4}$ of an inch.

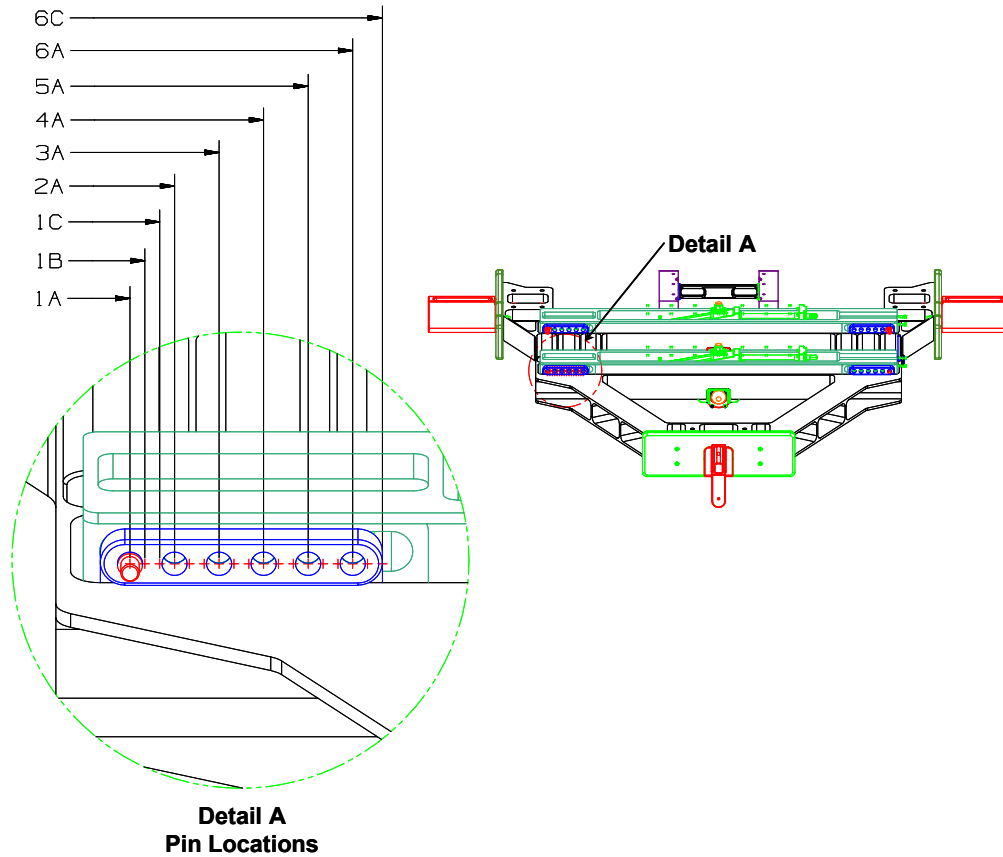


Figure 4.10-1 Pin Hole Identification

- 4.11. If the AMS-02 Passive PAS Assembly, P/N SEG39135815-301, arrives in the container with the Capture Bar facing up (Figure 4.11-3), skip to the next step. Remove the AMS-02 Passive PAS Assembly from the shipping crate per lifting plan in Appendix C Lift Plan. **The AMS-02 Passive PAS Assembly weighs approximately 170 lbs and will require 4 people to lift the assembly.** Place the assembly on wooden 4x4 blocks that are about one foot in length and surrounded by rubber padding. The rubber padding will prevent the blocks from slipping. The 4x4 blocks need to be placed underneath the Scuff Plates. The 4x4 blocks placed under the rear scuff plates needs to be positioned to allow the top surface of the rear scuff plates to come to rest when the AMS-02 Passive PAS Assembly is rotated 180 degrees. Rotate the AMS-02 Passive PAS Assembly until the Capture Bar faces up. See Figure 4.11-1,2, and 3 for the rotation sequence. During rotation of the AMS-02 Passive PAS Assembly, always maintain physical contact and do not allow the AMS-02 Passive PAS Assembly to fall or touch the ground.

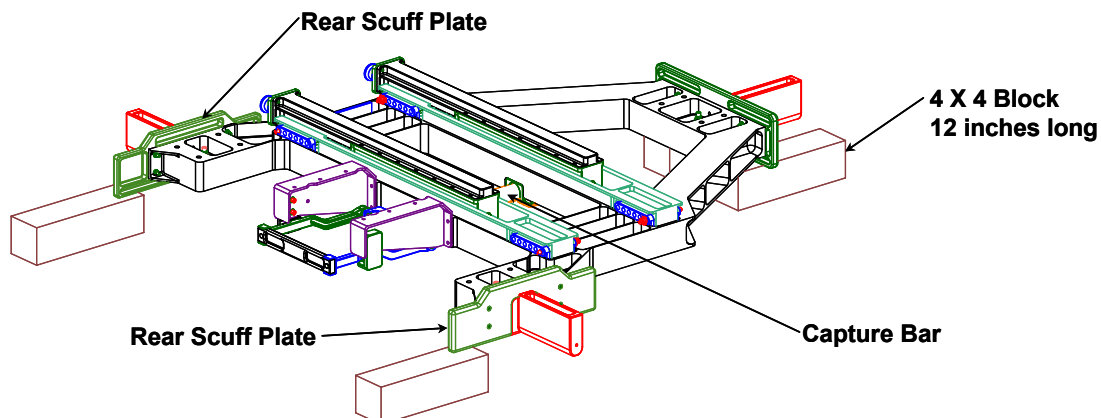


Figure 4.11-1: AMS-02 Passive PAS Assembly Rotation (Start Position)

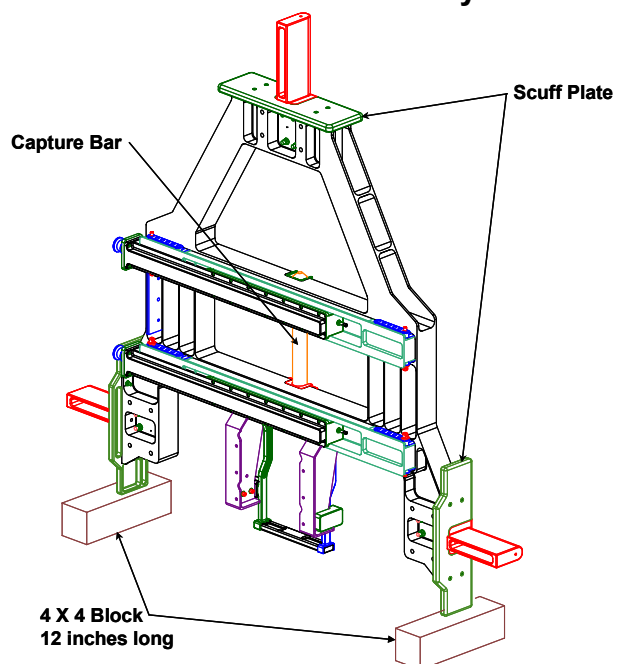


Figure 4.11-2: AMS-02 Passive PAS Assembly Rotation (Midpoint Position)

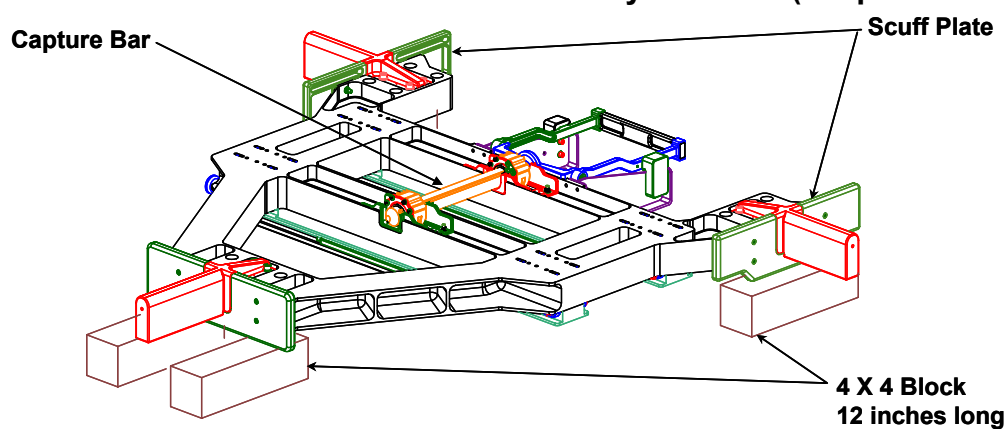
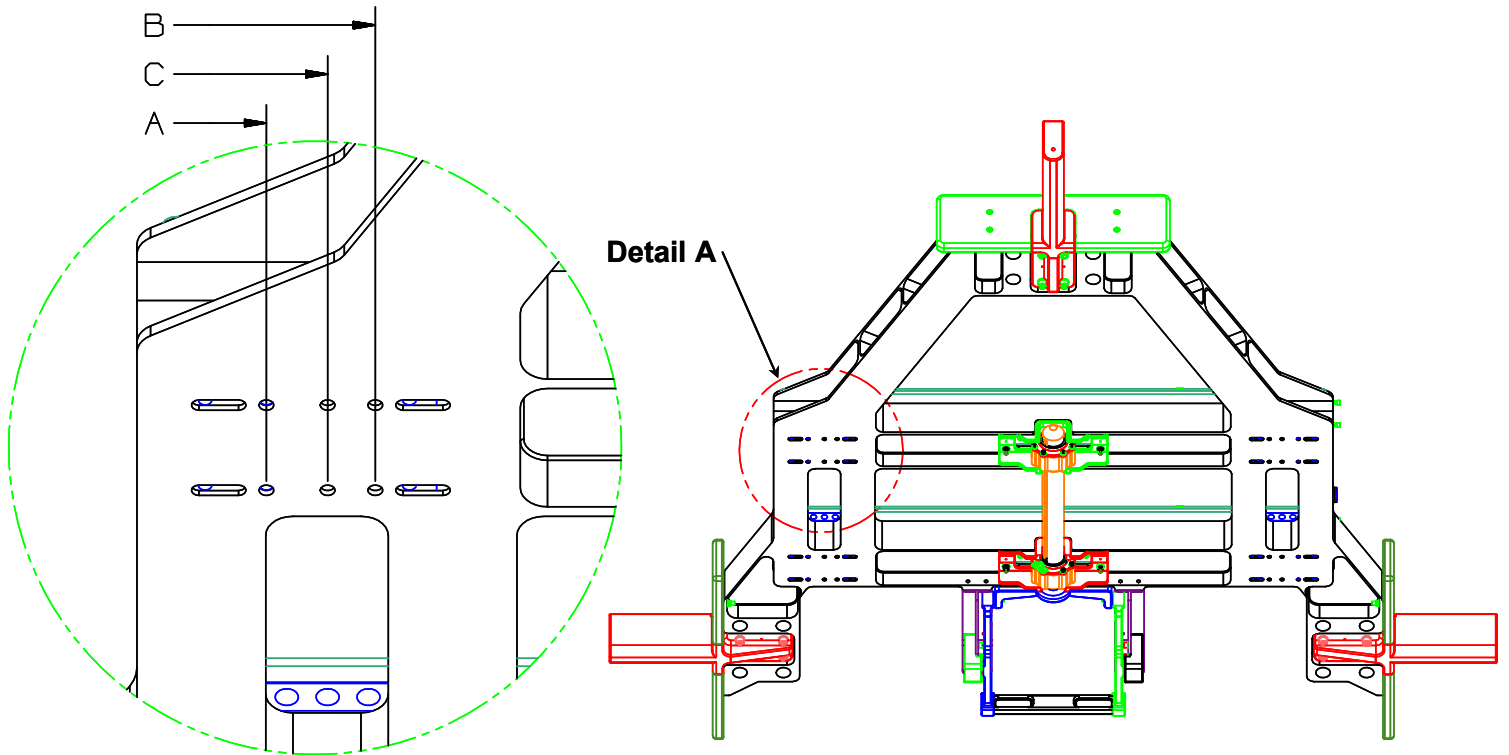


Figure 4.11-3: AMS-02 Passive PAS Assembly Rotation (End Position)

- 4.12. Label the bracket hole identification on the AMS-20 Passive PAS Assembly, P/N SEG39135815-301. Place a piece of Kapton Tape on the AMS-20 Passive PAS Assembly near the holes. Using a sharpie label the pin hole ID per Figure 4.12-1. Repeat for all four hole sets.



Detail A
Bracket Locations

Figure 4.12-1 Bracket Hole Identification

- 4.13. Check to insure that an Isolator, P/N SDG36144438-011 and -013, has been placed on top of the Shims, P/N SDG36144438-007 and -009. Lift the AMS-02 Passive PAS Assembly, P/N SEG39135815-301, per lift plan in appendix C. Place the mating surfaces of the AMS-02 Passive PAS Assembly, which is facing the ground, on top of the mating surfaces of the Lower USS Simulator Assembly, P/N SEG36144421-301. The AMS-02 Passive PAS weighs about 170 lbs and requires four people for lifting. Match the mounting surface on the AMS-02 Passive PAS Assembly to the mounting surface on the USS Bracket Simulator Assembly, P/N SEG36144425-301 and -303. See Figure 4.13-1 and 4.13-2. Do not allow the AMS-02 Passive PAS to contact the Lower USS Simulator Assembly.

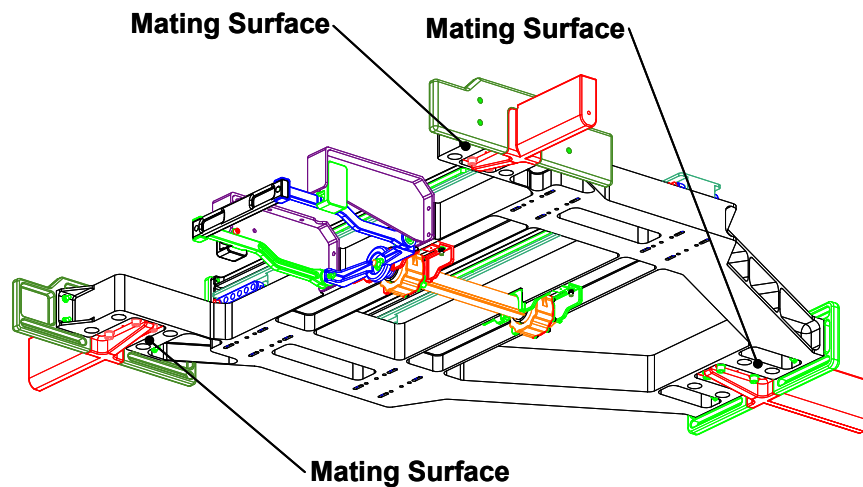


Figure 4.13-1: AMS-02 Passive PAS Assembly Mating Surface

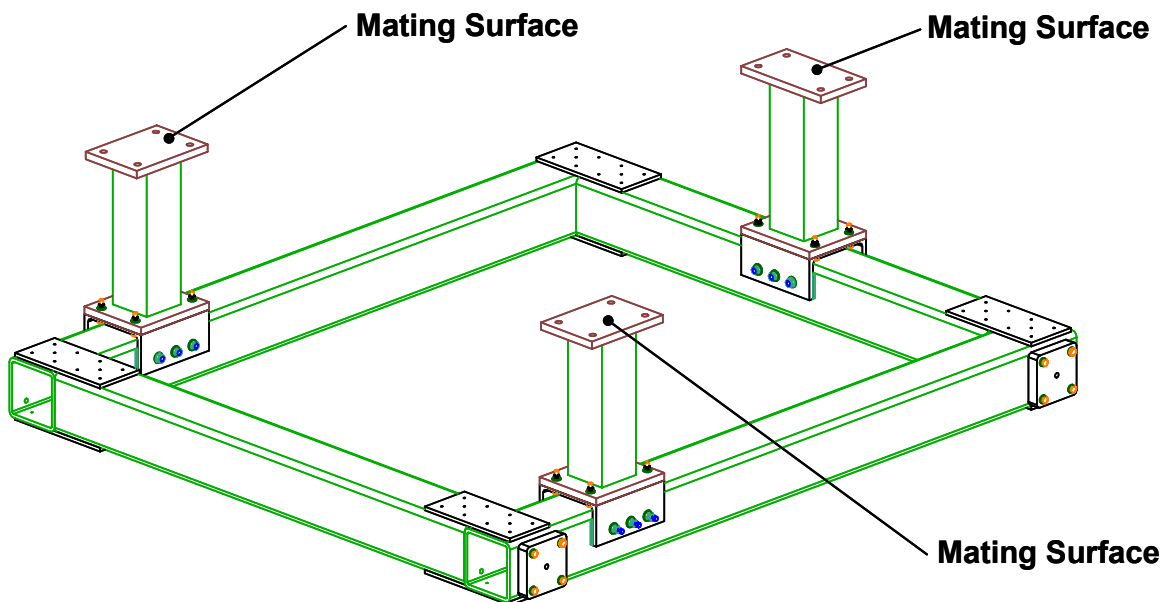


Figure 4.13-2: Lower USS Simulator Assembly Mating Surface

- 4.14. Fasten the AMS-02 Passive PAS Assembly, P/N SEG39135815-301, and the Lower USS Simulator Assembly, P/N SEG36144421-301, together using 12 NAS1956C38 .375-24UNJF-3A X 2.953 long hex head bolt and 12 NAS1805-6F .375-24UNJF-3B self-locking double hex nut. The torque values are 288 to 360 in-lbs above running/locking torque. Running/locking torque is 9.5 to 80 in-lbs. Install the bolt so that the bolt head is resting on the surface of the USS Bracket Simulator Assembly. See Figure 4.14-1.

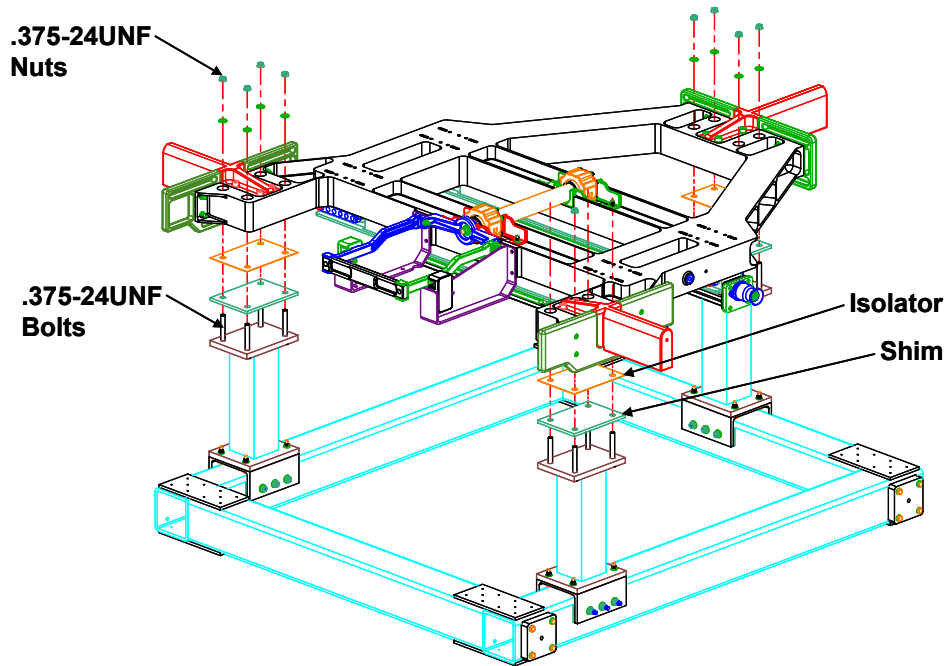


Figure 4.14-1: Assembly of AMS-02 Passive PAS Assembly to Lower USS Simulator Assembly

- 4.15. Measure the distance from the mounting surface of the AMS-02 Passive PAS Assembly to the either the bolt center of the bolts used in assembling the Lower USS Simulator to the USS Simulator Bracket Assembly, P/N SEG36144425-301 and -303, or the top surface of the tubes of Lower USS Center Body Simulator, P/N SEG36144422-301. If the distances are not within specified values of Table 4.15-1, remove the AMS-02 Passive PAS Assembly from the Lower USS Simulator Assembly and place the AMS-02 Passive PAS Assembly back on the blocks. Adjust the shims as needed to get the distance within specified value. Replace the shims and the isolator pads after adjustments.

Table 4.15-1: Required Distance Between Mounting Surface and USS Simulator Assembly

	Rear Bracket Assembly SEG36144425-301	Vertex Bracket Assembly SEG36144425-303
Bolt Center	13.22 inches +/- .01 inches	13.22 inches +/- .01 inches
Tube Top Surface	15.97 inches +/- .01 inches	15.97 inches +/- .01 inches

- 4.16. Install the Mounting Plate on the underside of bridge of the Test Frame Assembly, P/N SEG36144427-301. Secure the Mounting Plate with 4 NAS1008-9 .500-20UNJF-3A X1.404 long bolts. Use oversized washer 1.5 inch OD, P/N 90313A117, with the .500 inch fasteners. Apply SBT-8 Anti Seize Lubricant to the fastener and torque the fasteners between 387 and 455 in-lbs above running/locking torque. See Figure 4.16-1

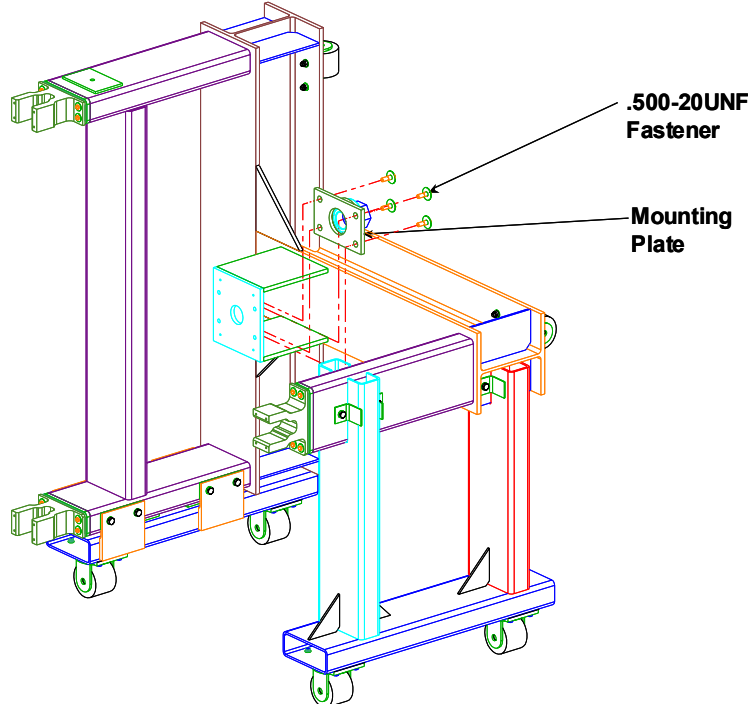


Figure 4.16-1: Mounting Plate Installation

- 4.17. Inspect the Load Rod, P/N SDG36144418-001, and the hex nuts, P/N SDG36144420-001 and -003, for nicks, cuts, scratch, and debris. Clean the debris and chase the threads if the engineer determines that the nicks, cuts, and scratches will gall the threads of the mating part.

- 4.18. Install the Interface model 1220 25K Load Cell onto the Load Rod, P/N SDG36144418-001. Apply SBT-8 Anti Seize Lubricant to the Load Rod and torque Load Rod to hand tight plus $1/6^{\text{th}}$ of a turn. .
- 4.19. Inspect the threads on the Clevis, P/N SDG36144417-001, for nicks, cuts, scratch, and debris. Clean the debris and the threads if the engineer determines that the nicks, cuts, and scratches will gall threads of the mating part.
- 4.20. Install the Clevis, P/N SDG36144417-001, to the Interface model 1220 25K Load Cell. Apply SBT-8 Anti Seize Lubricant to the Clevis and torque Clevis to hand tight plus $1/6^{\text{th}}$ of a turn.
- 4.21. Install the Load Rod, P/N SDG36144418-001, into the Hex Nut, P/N SDG36144420-001. Torque the Hex Nut or the Load Rod until there is about 2.5 inches of clearance between the surface of the Hex Nut and the hexagon surface of the Load Rod. Support the Load Rod or the Load Cell using a strap and the Test Fixture Assembly, P/N SEG36144426-301, to prevent damage to the Thrust Bearing, P/N 5310. See Figure 4.21-1.

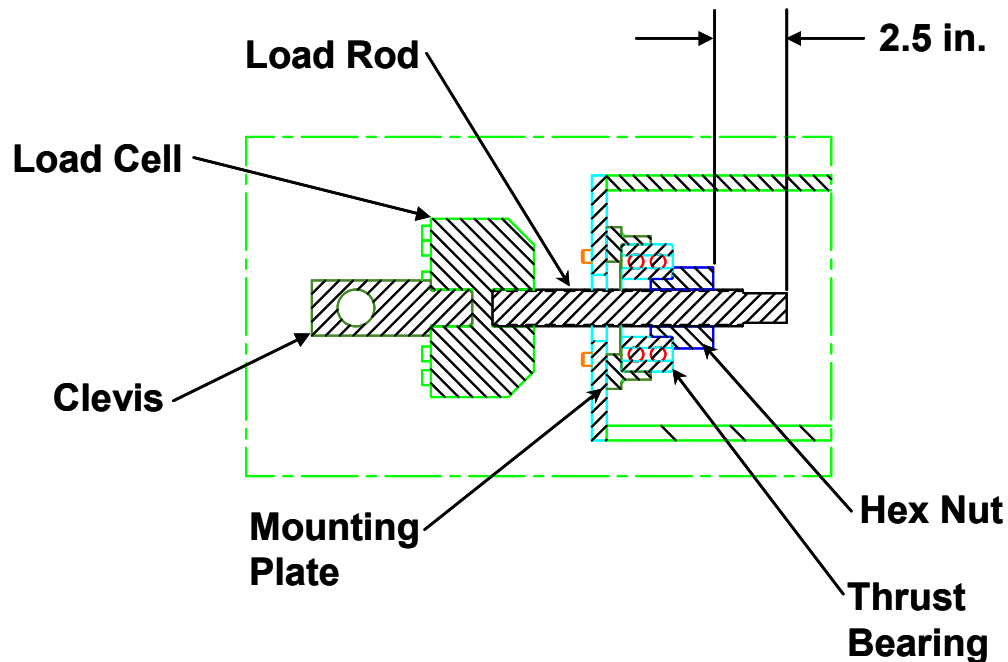


Figure 4.21-1: Load Rod Installation

- 4.22. Align the hole for the $1\frac{1}{4}$ diameter Pivot Pin, P/N SDG36144415-001, on the Clevis, P/N SDG36144417-001, with the hole on the Top Box Beam, P/N SDG36144413-001. Support the Top Box Beam and the Bottom Box Beam, P/N SDG36144413-003, to aid in next step.

- 4.23. Assemble the Top Box Beam, P/N SDG36144413-001, to the Clevis, P/N SDG36144417-001, using a 1¼-inch diameter Pivot Pin, P/N SDG36144415-001, and 2 Bushing, P/N SDG36144414-001. Thread the Pivot Pin through the hole on the Clevis and the hole on the Top Box Beam. Install the Bushing on both side of the Clevis to center the Clevis. Secure the Box Beam and the Clevis together using 2 1¼-12UNF nut. Torque the 1¼-12UNF nuts finger tight plus 1/6th of a turn. The Bushings may need to be machined to center the Clevis and allow a flush fit with the outside tube wall prior to installing the 2 1¼-12UNF nut. See Figure 4.23-1. To aid in installation, use a small amount of SBT-8 Anti Seize Lubricant.

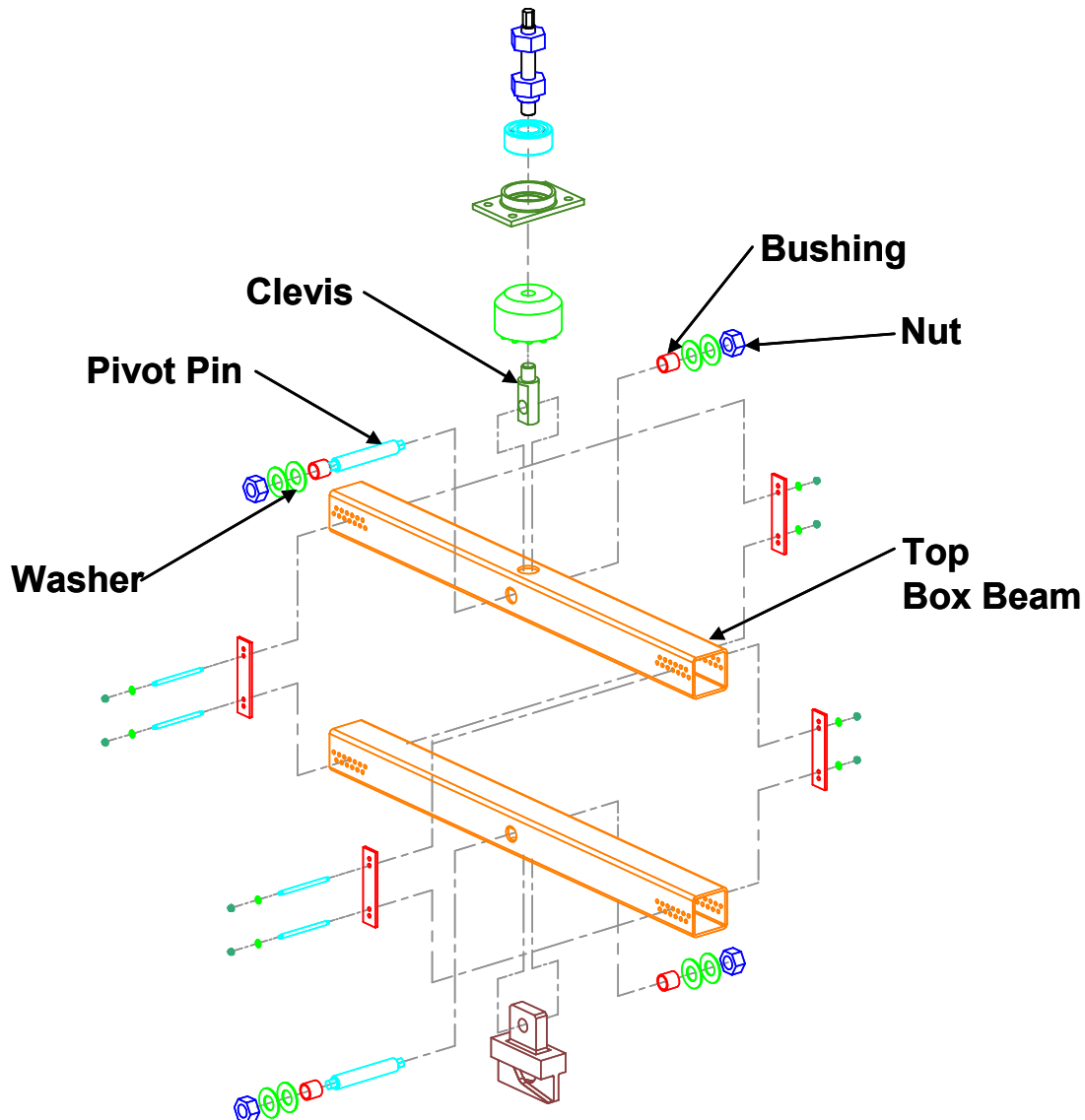


Figure 4.23-1: Top Box Beam Installation

- 4.24. If the Top and Bottom Box Beam, P/N SDG36144413-001 and – 003, are assembled skip to next step. Assemble Bottom Box Beam, P/N SDG36144413-003, to Top Box Beam, P/N SDG36144413-001, using 4 Pivot Plates, P/N SDG36144416-001; 4 Pivot Pin, P/N SDG36144415-003; and 8 .375-24UNF nuts. Torque the .375-24UNF nuts finger tight plus 1/6th of a turn. See Figure 4.24-1. To aid in installation, use a small amount of SBT-8 Anti Seize Lubricant.

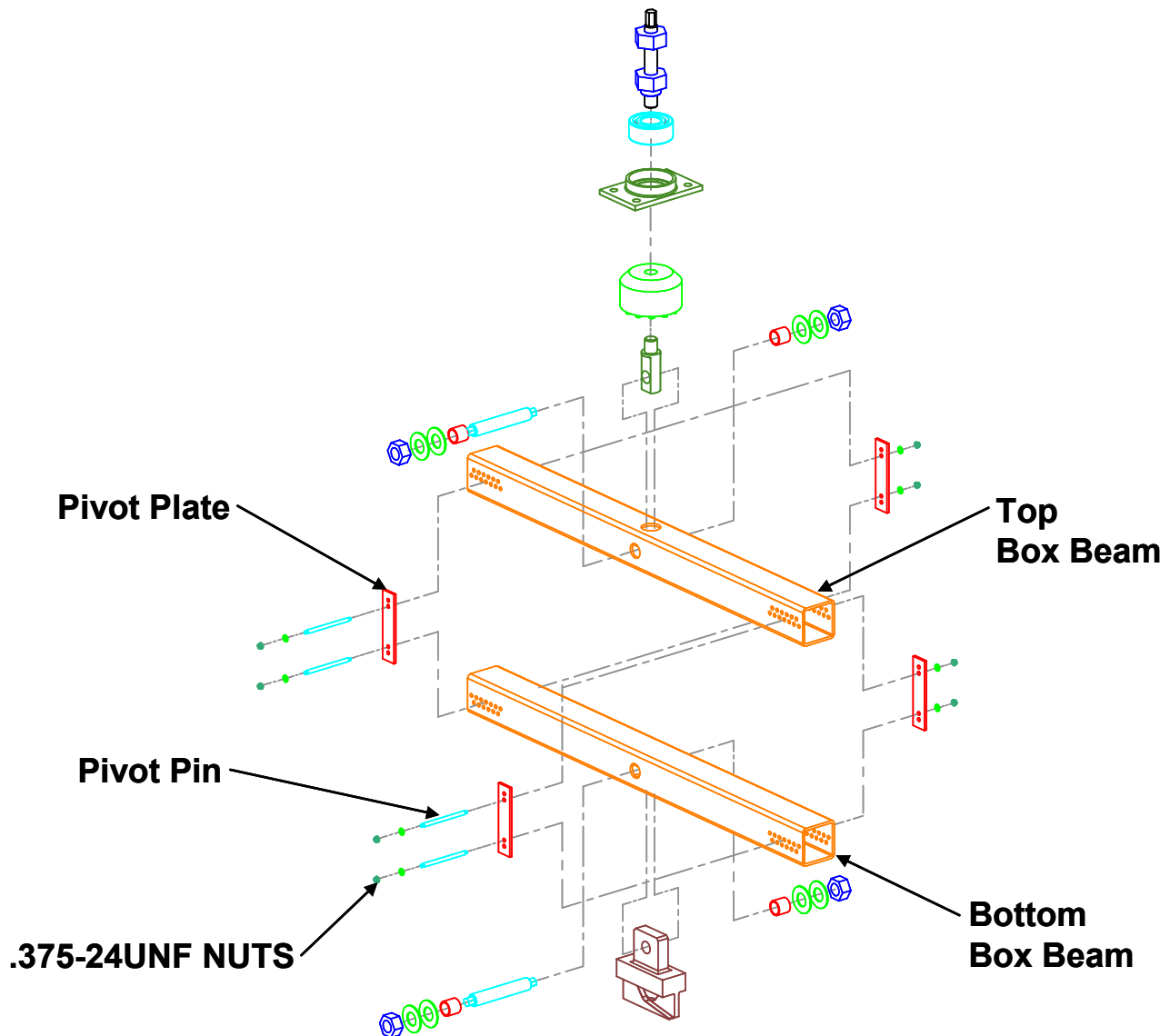


Figure 4.24-1: Bottom Box Beam Installation

- 4.25. Repeat Step 4.23 except install and center the Latch Simulator, P/N SDG36144412-001 instead of the Clevis, P/N SDG36144417-001. See Figure 4.25-1.

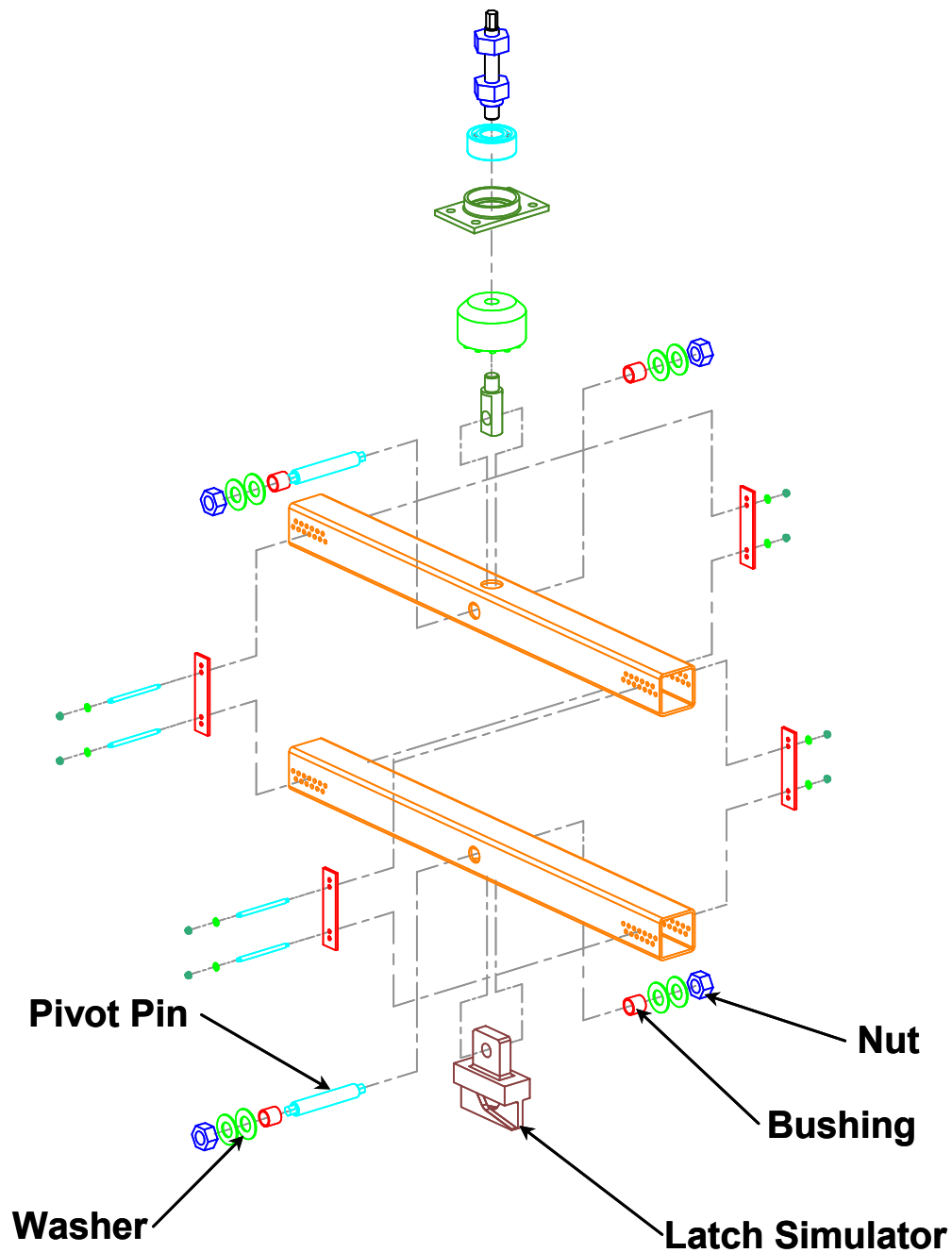


Figure 4.25-1: Latch Simulator Installation

- 4.26. Adjust the APAS Support Arm, P/N SDG36144439-001, until the Take-Up Bolt, P/N SDG36144440-001, is along the centerline and between the Top and Bottom Box Beams, P/N SDG36144413-001 and SDG36144413-003. Suspend the APAS Simulator Assembly, P/N SEG36144411-301, by attaching the AMS provided Vectran cord to the .375 Diameter Pivot Pins, P/N SDG36144415-003, and thread the Vectran cord through the hole on the Take-Up Bolt, P/N SDG36144440-001. Remove all slack from the cord. Secure the APAS Support Arm by torquing the .500-20UNF fastener to between 387-455 in-lbs. See Figure 4.26-1

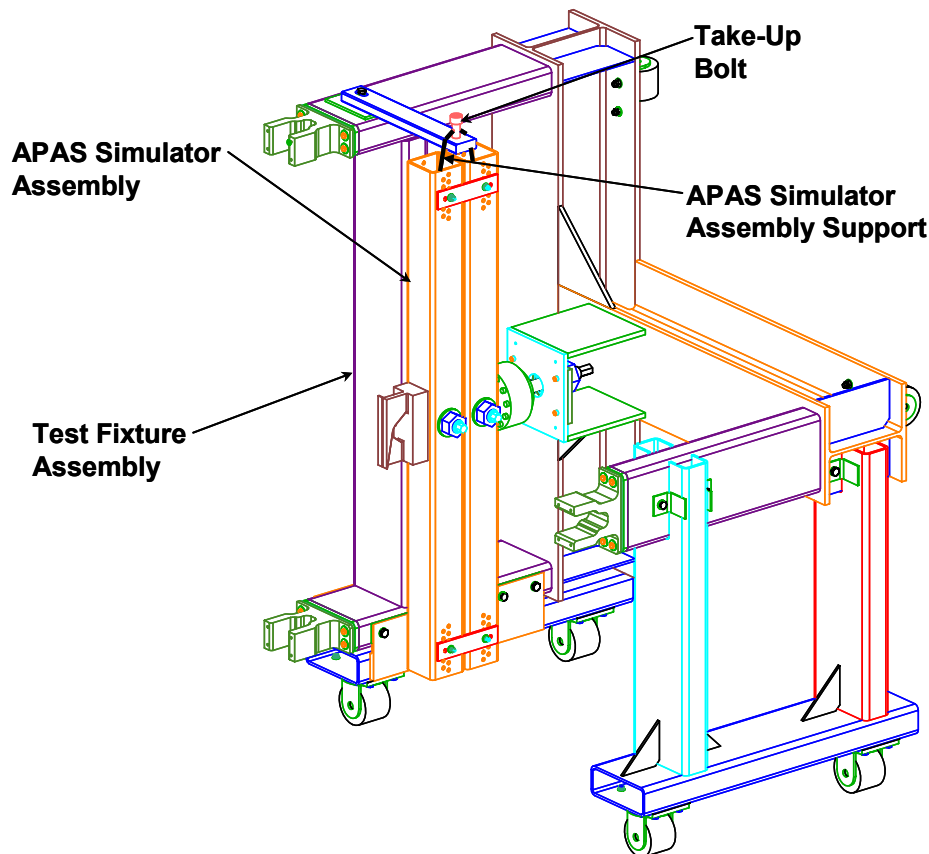


Figure 4.26-1: APAS Simulator Assembly.

- 4.27. Remove the support for the Interface model 1220 load cell.
- 4.28. Remove the Capture Bar from the AMS-02 Passive PAS Assembly. See Figure 4.11-1,2, and 3 for Capture Bar identification. Remove the Capture Bar per procedure in appendix D.
- 4.29. Attach guideline to the Rear USS Simulator Bracket Assembly, P/N SEG36144425-301, which is opposite the Lifting Attachment Points. Also attach guideline to the Vertex USS Simulator Bracket Assembly, P/N SEG36144425-303.

- 4.30. Attach the lines of the Lifting Hoist, P/N SEG36145105-701, labeled Lower USS Simulator to the lifting pads on the Lower USS Simulator Assembly, P/N SEG36144421-301. Attach the remaining line to the Lifting Plate, P/N SDG36144432-001. Torque the swivel hoist on the lifting hoist to 12 ft-lbs. See Figure 4.30-1. Adjust the Turn Buckles, P/N 1032652, for maximum adjustability (minimize the distance between the Jaws).

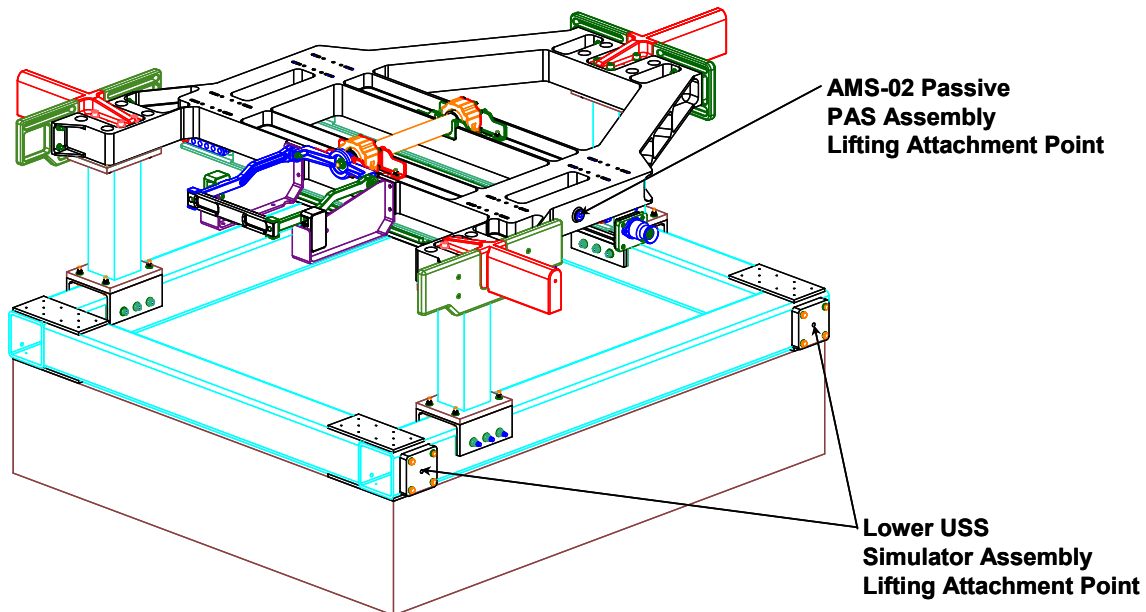


Figure 4.30-1: Lifting Hoist Attachment Point

- 4.31. Attach the Lifting Hoist, P/N SEG36145105-701, to the crane. Follow the safety instructions on the crane. Extend the legs of the crane so that the lifting arm of the crane will be within the extended legs when the PAS Lower USS Simulator Assembly, P/N SEG36145110-301, is lifted.
- 4.32. Slowly lift the Lower USS Simulator Assembly, P/N SEG36144421-301, and the AMS-02 Passive PAS Assembly, P/N SEG39135815-301. Do not damage the AMS-02 Passive PAS Assembly during the lift. Use the guideline to prevent the PAS Lower USS Simulator Assembly, P/N SEG36145110-301, from swinging. See Figure 4.32-1.

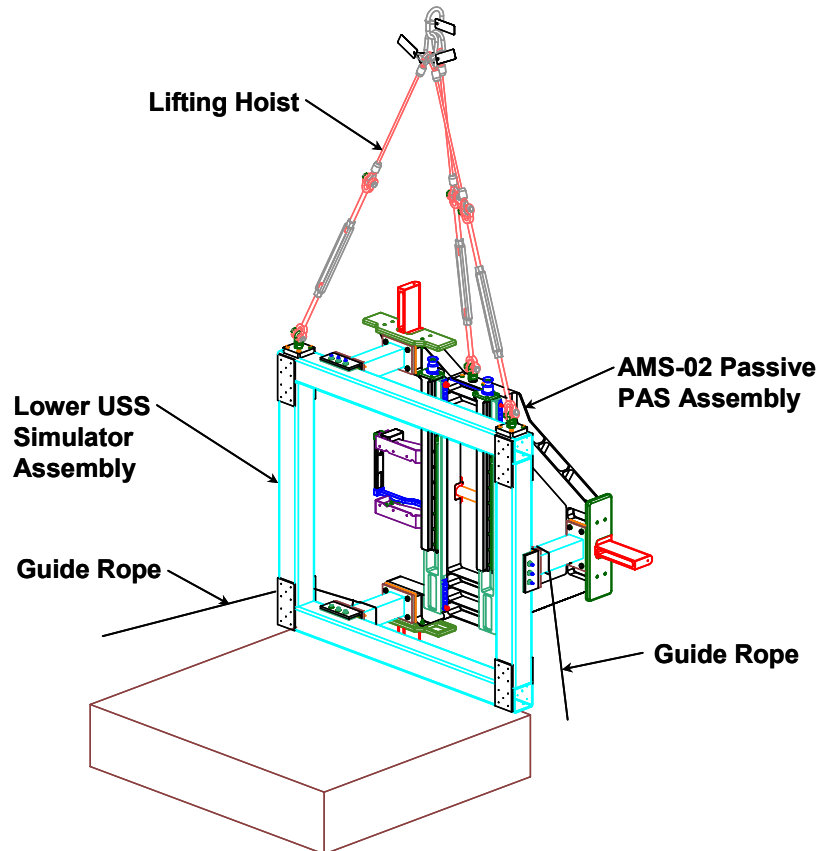


Figure 4.32-1: Lifting

- 4.33. Use a 24-inch level to measure the AMS-02 Passive PAS Assembly, P/N SEG39135815-301. Adjust the Turn Buckles, P/N 1032652, to level the assembly in the X, Y, and Z.
- 4.34. Move the table that the AMS-02 Passive PAS Assembly was sitting on. **Move the Test Fixture Assembly, P/N SEG36144426-301, to the suspended AMS-02 Passive PAS Assembly.** Lock the Casters on the Test Fixture Assembly when the engineers have determined that the AMS-02 Passive PAS Assembly is close enough to the Test Fixture Assembly.
- 4.35. Position the AMS-02 Passive PAS so that the Guide Pins will sit in the Guide Vane Simulators, P/N SDG36144434-30X. Slowly move the AMS-02 PAS into the Guide Vane Simulators, P/N SDG36144434-30X. The gap between the Scuff Plates and the Guide Vane Simulator Assemblies are in Table 4.35-1. See Figure 4.1-1 for Guide Vane Simulator Designation.

Table 4.35-1 Gap Distance Between Guide Vanes and Scuff Plates

	-301 Guide Vane Simulator Assembly	-303 Guide Vane Simulator Assembly	-305 Guide Vane Simulator Assembly
Distance	.55 inches	.55 inches	.57 inches

- 4.36. Secure the guide pins of the AMS-02 PAS within the Guide Vane Simulator, P/N SDG36144434-30X by temporarily installing each of the Retaining Plates, P/N SDG36144435-001, to the Guide Vane Simulator, P/N SDG36144434-30X. Each Retaining Plate will require 4 .190-32UNF x .793 long fastener. **Torque fasteners to hand tight.**

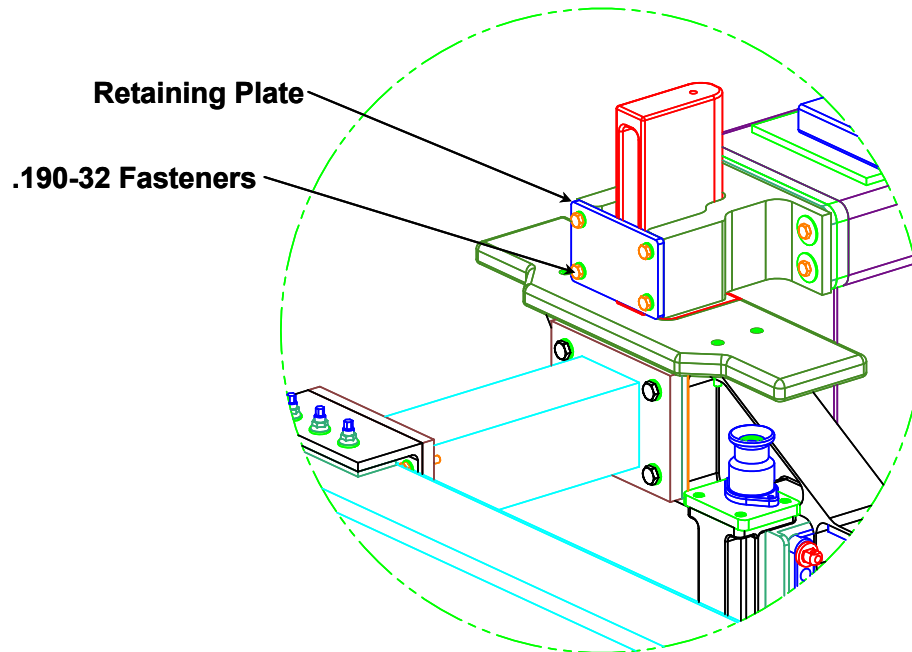


Figure 4.36-1: Retaining Plate Installation

- 4.37. Reinsert the Capture Bar by following the AMS-02 Passive PAS Assembly Capture Bar Installation Procedure in Appendix E. Adjust the Load Rod, P/N SDG36144418-001, as needed to allow the Capture Bar to pass through the triangular hole on the Latch Simulator, SDG36144412-001. Adjust both the Load Rod and the Capture Bar until the Capture Bar is in the final location. Install Capture Bar per Appendix E.

- 4.38. Install the Sensor Frame, P/N SEG36145111-301, to the Test Fixture Assembly, P/N SEG36144426-301. Install the 3 sides of the Sensor Frame first. See Figure 4.37-1. Attach the sides to the Guide Vane Simulator, P/N SDG36144434-30X, using .190-32UNF X 1.0 long socket head cap screws. See Figure 4.37-2. **DO NOT** damage the AMS-02 Passive PAS Assembly, P/N SEG39135815-301, during installation of the Sensor Frame.

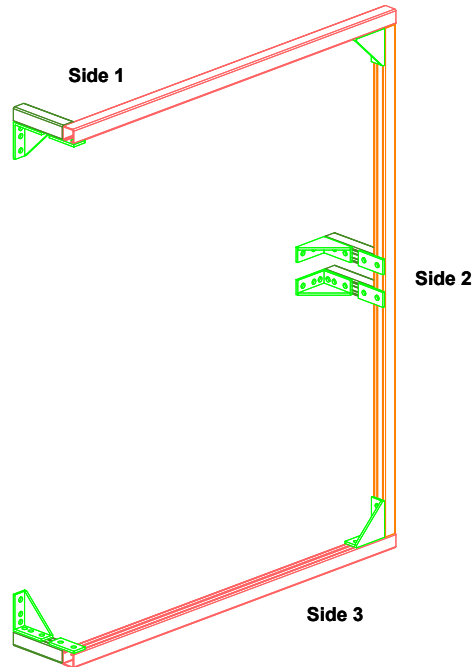


Figure 4.37-1: Sensor Frame

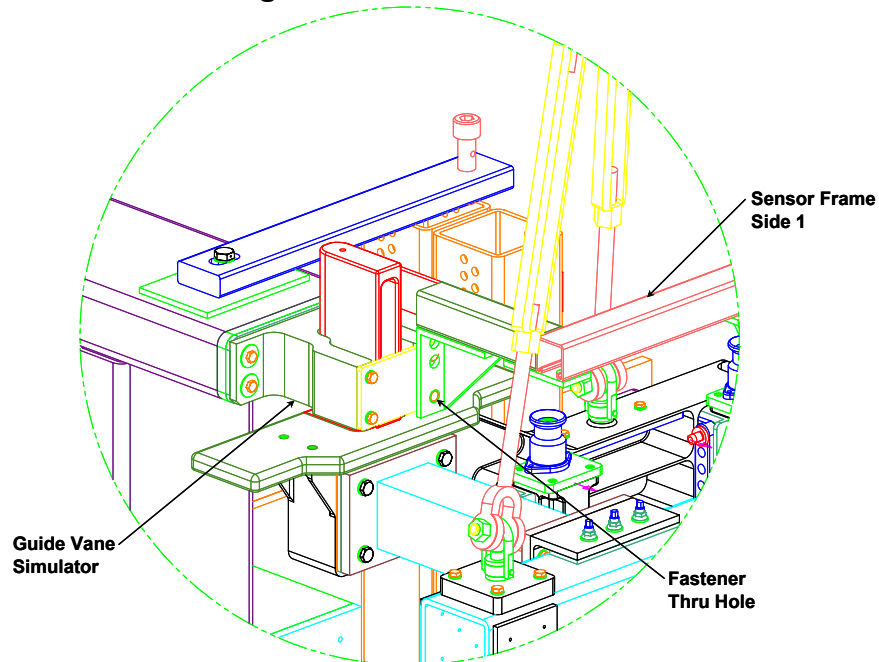


Figure 4.37-2: Sensor Frame Interface

- 4.39. Install the remaining Bridge Channels, P/N SDG36145111-003, and Sensor Channels, P/N SDG36145111-007, to complete the Sensor Frame, P/N SEG36145111-301 per drawing SEG36145111-301. See Figure 4.39-1. **DO NOT** damage the AMS-02 Passive PAS Assembly, P/N SEG39135815-301, during installation. Adjust the Sensor Channels as needed to meet the sensor requirements of section 5.0. See Figure 4.39-2 for a completed PAS Static Test Assembly

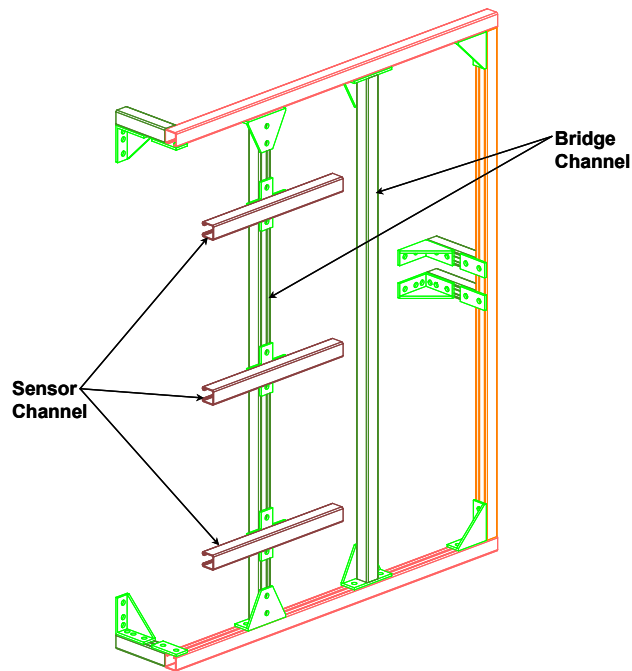


Figure 4.39-1: Bridge and Sensor Channel Installation

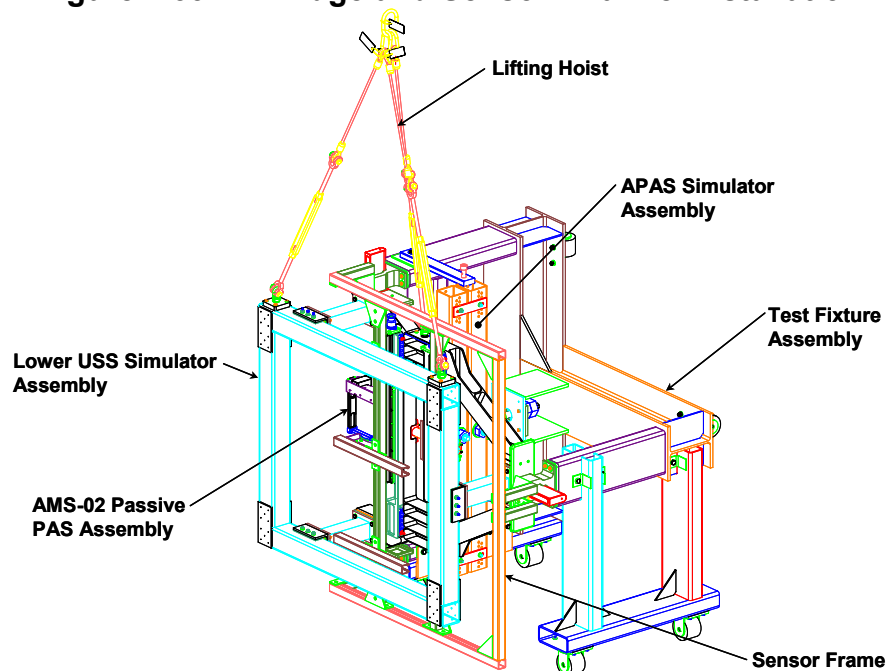


Figure 4.39-2: PAS Static Test Assembly

5.0 Test Instrumentation

5.1. The PAS will require the following instrumentation (see Table 5.1-1 for a list of gages):

- 8 Deflection gages
 - Accuracy of +/- 1.0% of expected deflection.
 - Resolution of +/- 0.005 inches.
- 8 Triaxial Strain gages
- 1 Load Cell

Table 5.1-1 Summary of Strain and Deflection Gages

Location	Description	Sensor Type	QTY	Sensor ID	Channel
PAS Base Assembly	See Figure 5.4-1	Rosette	1	1	3
PAS Base Assembly	See Figure 5.4-2	Rosette	1	2	3
PAS Base Assembly	See Figure 5.4-3	Rosette	1	3	3
PAS Base Assembly	See Figure 5.4-1, 2	Rosette	1	4	3
PAS Base Assembly	See Figure 5.4-1, 2	Rosette	1	5	3
PAS Base Assembly	See Figure 5.4-3	Rosette	1	6	3
Vertex Bridge Assembly	See Figure 5.4-4 and 5	Rosette	1	7*	3
Rear Bridge Assembly	See Figure 5.4-4 and 5	Rosette	1	8*	3
		Sub-Total	8		24
Capture Bar	Center of Capture Bar	Deflection Gage	1	A	1
Capture Bar	Rear end of Capture Bar	Deflection Gage	1	B	1
Capture Bar	Vertex end of Capture Bar	Deflection Gage	1	C	1
PAS Platform Assembly	See Figure 5.4-6	Deflection Gage	1	D	1
PAS Platform Assembly	See Figure 5.4-6	Deflection Gage	1	E	1
Bridge Pin	Rear end of Vertex +Y Bridge Pin	Deflection Gage	1	F	1
Bridge Pin	Rear end of Vertex -Y Bridge Pin	Deflection Gage	1	G	1
Bridge Pin	Vertex end of Rear -Y Bridge Pin	Deflection Gage	1	H	1
Bridge Pin	Vertex end of Rear +Y Bridge Pin	Deflection Gage	1	J	1
Load Cell	Mounting Surface of Load Cell	Deflection Gage	1	K	1
		Sub-Total	10		10
APAS Simulator Assembly	Connection between Load Rod and Clevis	Load Cell	1	L1	1
		Sub-Total	1		1
		Total	19		35

*This gage will be bonded to a nickel plated surface

5.2. For gage setup, use material properties shown in Table 5.2-1.

Table 5.2-1 Material Properties for Strain Gage Setup

Location	Material	E x 10 ⁶ psi		ν
		Tension	Compression	
PAS Base Assembly	Aluminum 7050-T7451 Plate*	10.3	10.6	.33
PAS Bridge	Aluminum 7050-T7451 Plate*	10.3	10.6	.33

*Sections of the aluminum 7050-T7451 have a nickel plated surface.

5.3. Each gage should be clearly labeled with the gage number. See Table 5.3-1 for a summary of deflection gages. The expected deflection is listed in Table 5.3-1.

Table 5.3-1 Deflection Gage Summary

Location	Description	Gage #	Axis	Expected Deflection
Capture Bar	Center of Capture Bar	A	Z	<1.0 inches
Capture Bar	Rear end of Capture Bar	B	Z	<1.0 inches
Capture Bar	Vertex end of Capture Bar	C	Z	<1.0 inches
PAS Base Assembly	See Figure 5.4-6	D	Z	<1.0 inches
PAS Base Assembly	See Figure 5.4-6	E	Z	<1.0 inches
Bridge Pin	Rear end of Vertex +Y Bridge Pin	F	Z	<1.0 inches
Bridge Pin	Rear end of Vertex -Y Bridge Pin	G	Z	<1.0 inches
Bridge Pin	Vertex end of Rear -Y Bridge Pin	H	Z	<1.0 inches
Bridge Pin	Vertex end of Rear +Y Bridge Pin	J	Z	<1.0 inches
Load Cell	Mounting Surface of Load Cell	K	Z	<1.0 inches

5.4. Configure gages per Figures 5.4-1 to 5.4-9. Relocation of some gages might be necessary due to the accessibility of the desired location on the test article. Instrumentation personnel and AMS personnel will need to agree upon the placement of the relocated sensors for practicality of the location and usefulness of the data that will be collected.

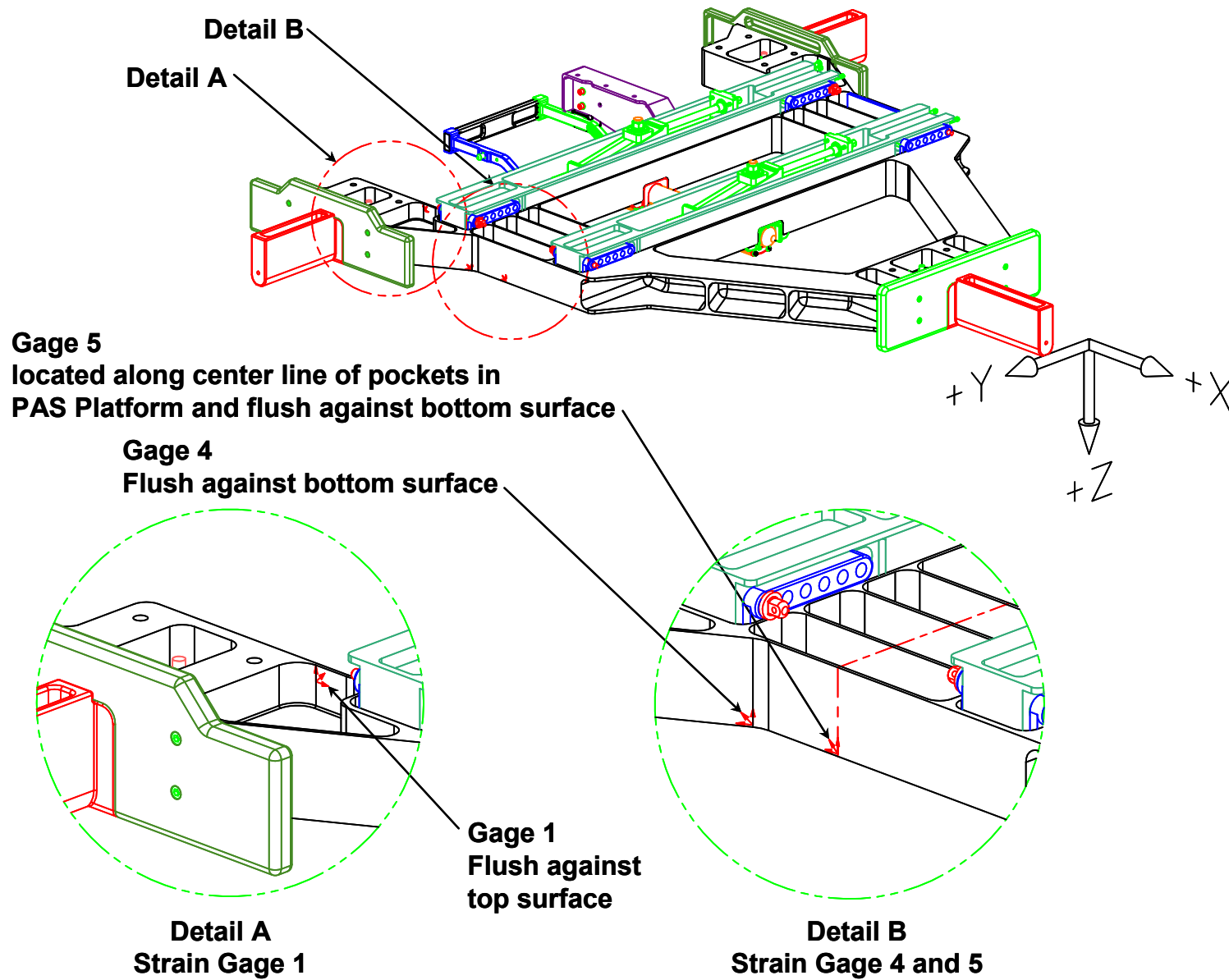


Figure 5.4-1: Strain Gage 1, 4, and 5 Location

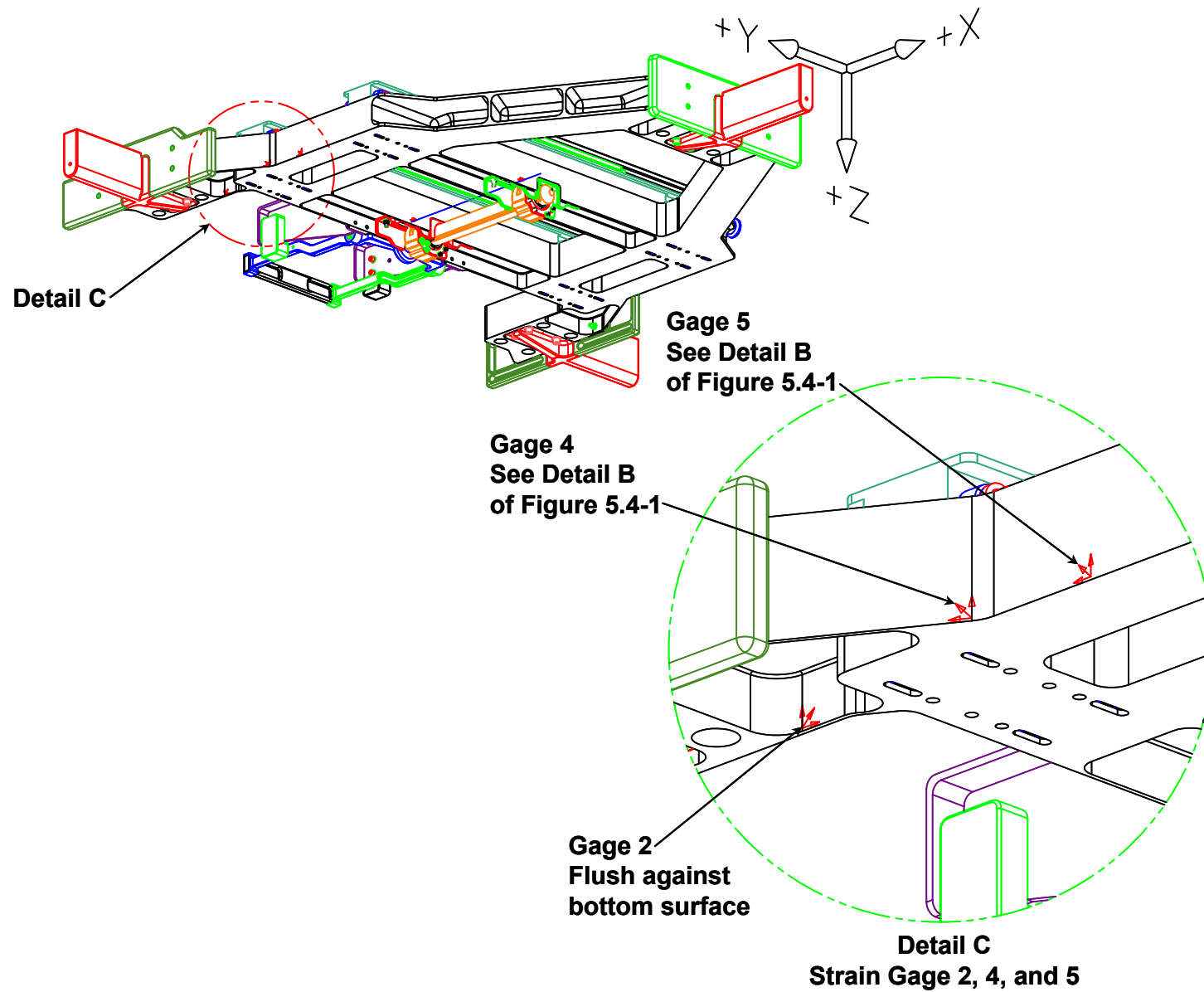


Figure 5.4-2: Strain Gage 2, 4, and 5 Location

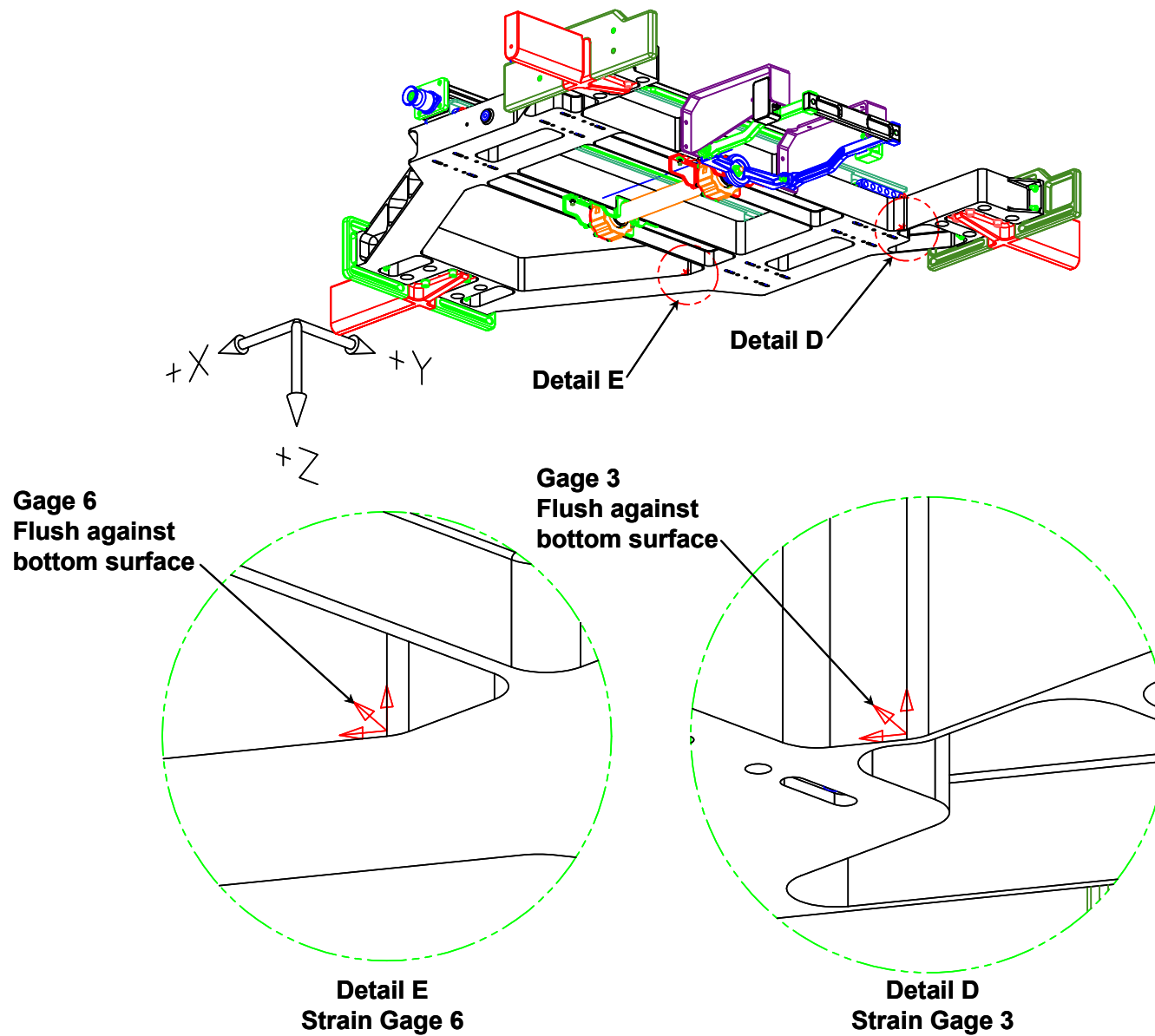


Figure 5.4-3: Strain Gage 3 and 6 Location

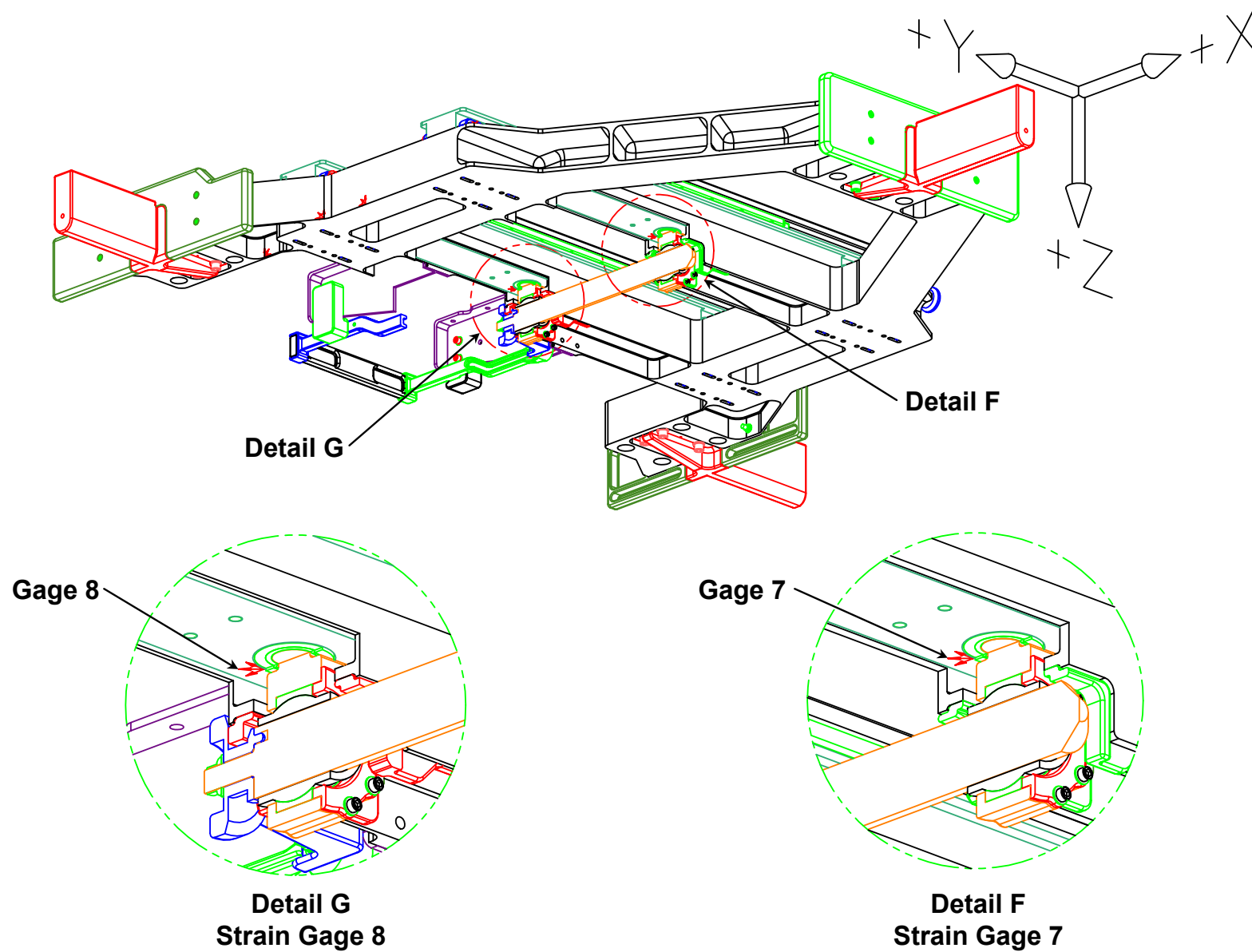
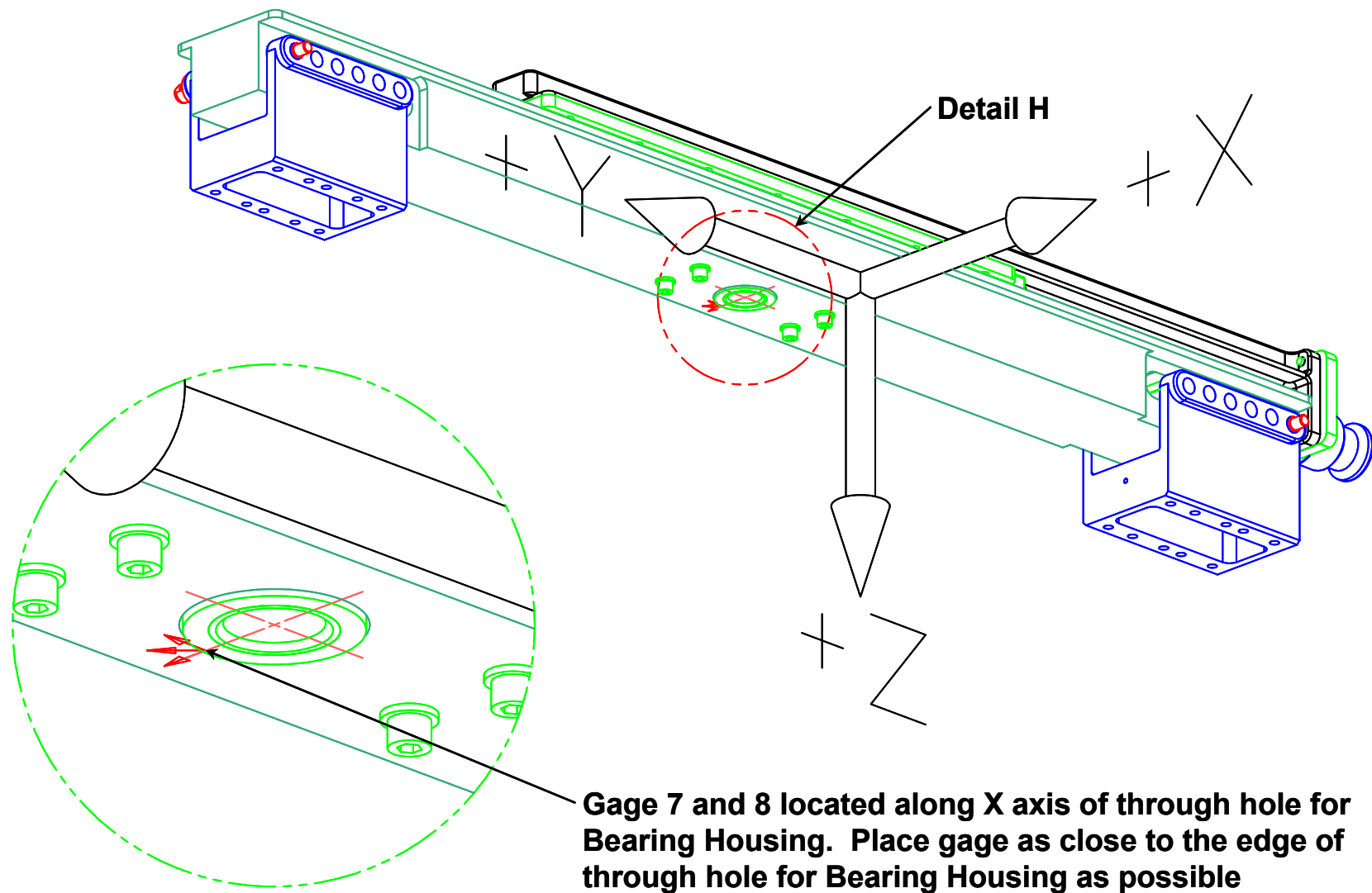


Figure 5.4-4: Strain Gage 7 and 8 Location



Detail H
Strain Gage 7 and 8

Figure 5.4-5: Strain Gage 7 and 8 Location Detail

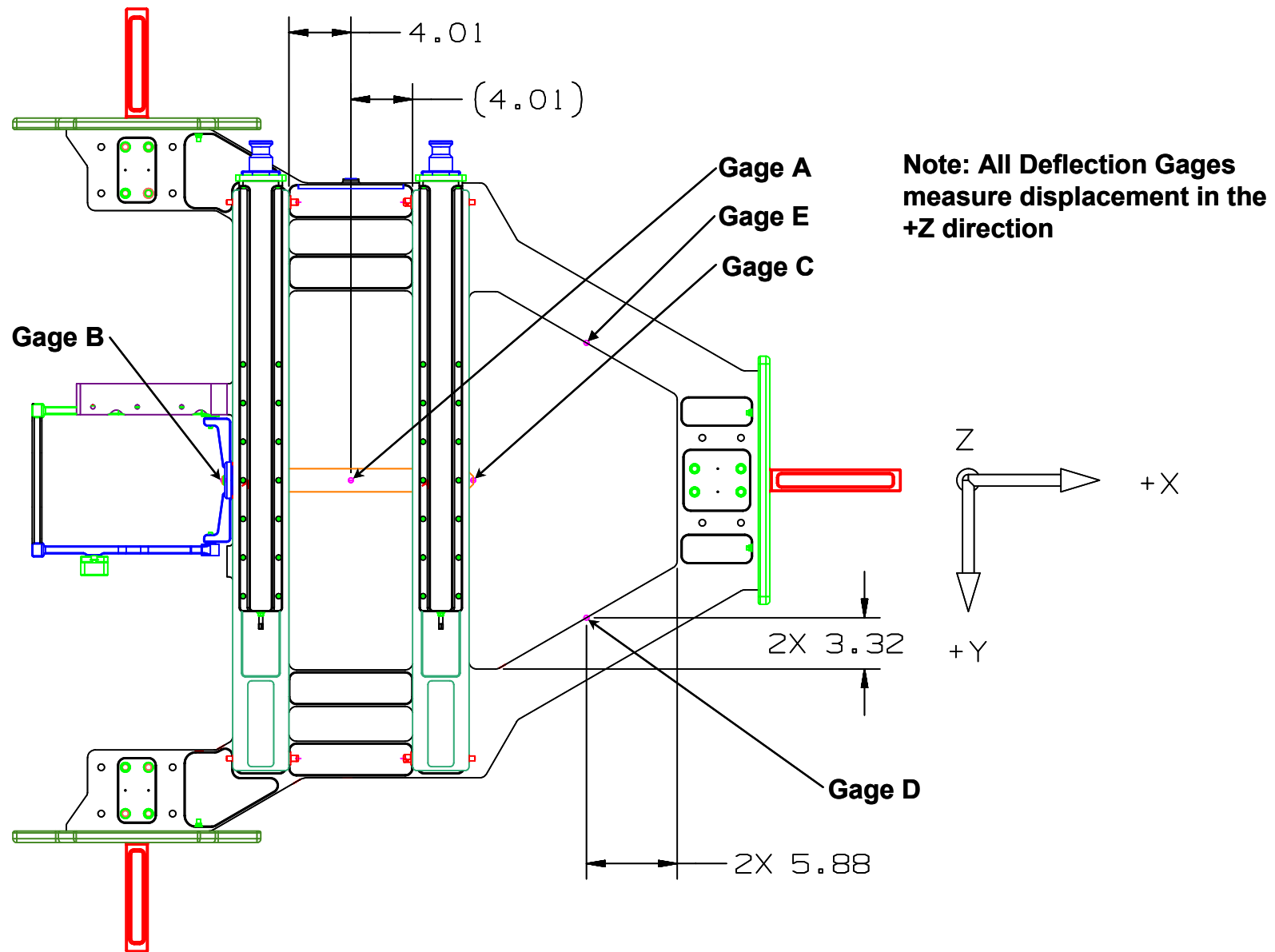


Figure 5.4-6: Deflection Gage A, B, C, D, and E Location

Note: All Deflection Gages measure displacement in the +Z direction

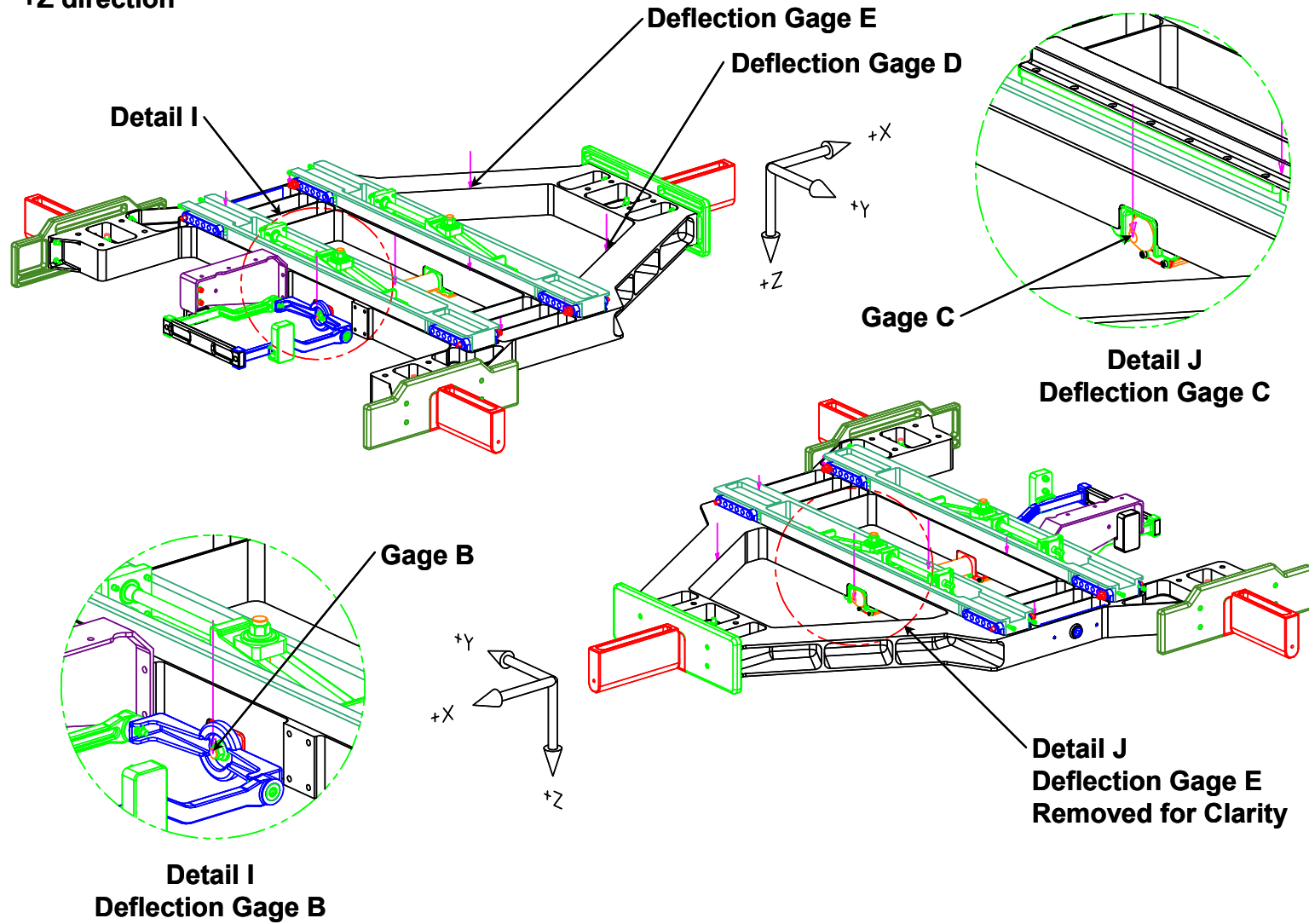
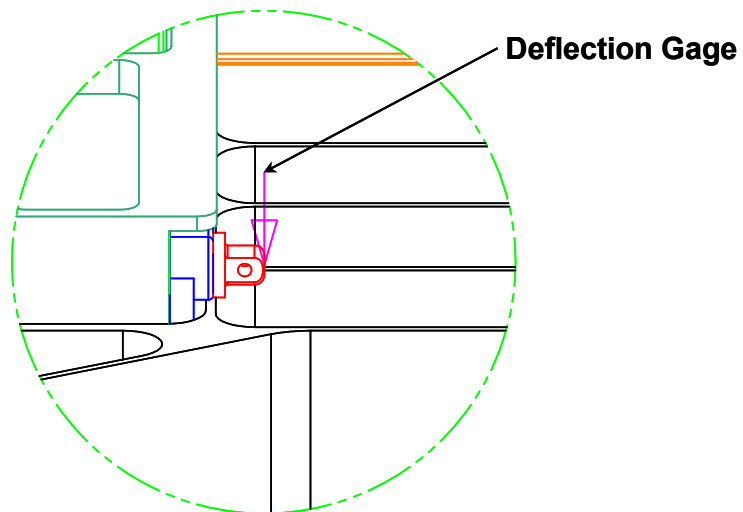
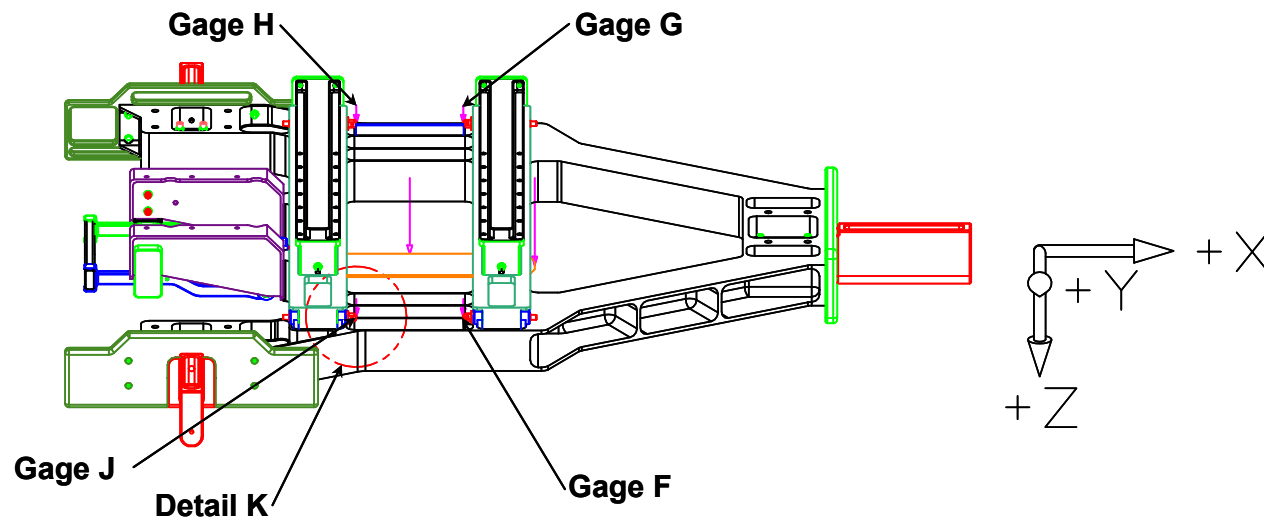


Figure 5.4-7: Deflection Gage B, C, D, and E Location



**Note: All Deflection Gage
measure displacement in the
+Z direction**

Detail K
Deflection Gage F, G, H, and J

Figure 5.4-8: Deflection Gage F, G, H, and J Location

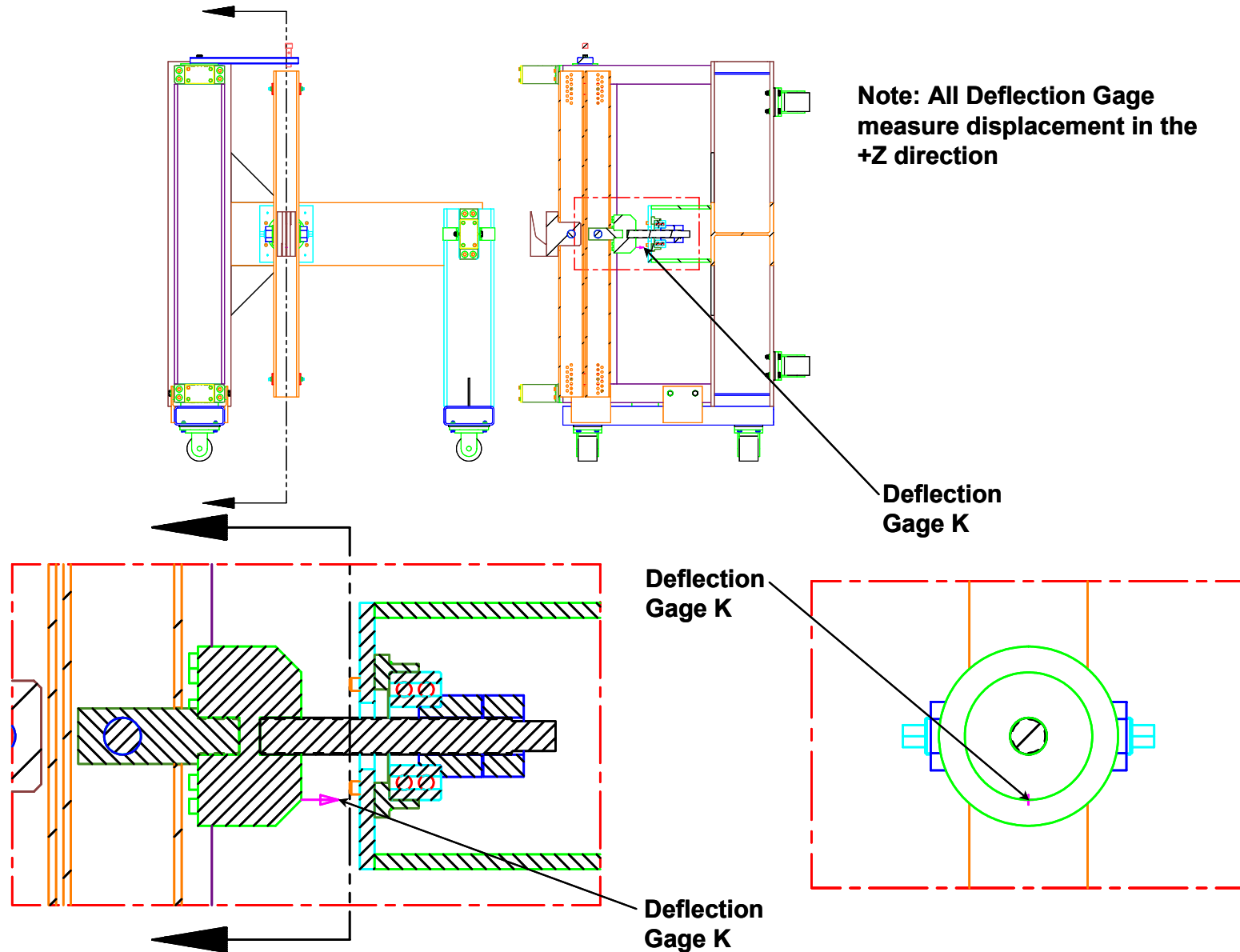


Figure 5.4-9: Deflection Gage K Location

6.0 Data Requirements

Test lab personnel shall coordinate and deliver the following data:

- 6.1. Photographic documentation (digital and conventional still camera) of the test set-up and gage location is required. These photos should show the gages orientation and the gage number labels.
- 6.2. Strain versus percent load for each strain gage.
- 6.3. Deflection versus load for each deflection gage.
- 6.4. Real time readouts of gages 1, 7, 8, A, B and C data channel on a display monitor for the Test Engineer and Stress Analyst. If possible, real time readouts of all gages for Stress Analyst.
- 6.5. Real time graphical plots of gages 1, 7, 8, A, B and C data channel on a separate display monitor for the Test Engineer and Stress Analyst.
- 6.6. Numerical data should be delivered in hard copy and in electronic (ASCII or EXCEL file) format.
- 6.7. Test Data Package including test notes, control documentation, instrumentation, test data and other applicable data.

7.0 Test Procedure

7.1. Stiffness Calibration Test Procedure

- 7.1.1. Remove the 2 NAS1003-9 .190-32UNJF-3A X 1.043 long hex head bolt and the 2 .190-32UNJF-3B self-locking hex nut that secures the lifting plate.

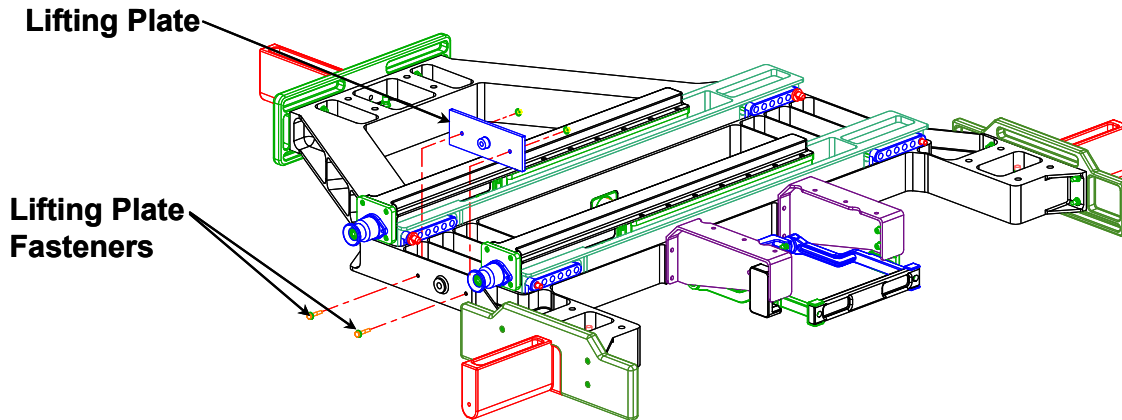


Figure 7.1.2-1: Lifting Plate Fasteners

- 7.1.2. Remove the 4 .250-28UNJF-3B self-locking hex nut used to secure the Bridge Pins, P/N SDG39135826-001, and replace these hex nuts with the AN316C4R for the duration of the test. Remove and replace the nuts one at a time. Torque nuts to hand tight. If needed, use another AN316C4R as a jam nut.
- 7.1.3. Verify the initial position of the Bridge Pins, P/N SDG39135826-001. The Bridge Pins should be in hole set 6A. Verify the initial position of the PAS Base Bridge Brackets, P/N SDG39135824-001. The middle fastener for the PAS Base Bridge Brackets should be mounted in position A. See Figure 7.1.7-1, 2, and 3.
- 7.1.4. Torque the Nut, SDG36144420-001, on the NTN Bearing, P/N 5310, to 2000 lbf (approximately 42 ft-lbs or 500 in-lbs) as indicated by the output of the load cell. Use the hex head on the pivot pin to aid in loading the test assembly.
- 7.1.5. Unload the test assembly and record the output of deflection gage B and C. The output of both gage need to be within +/- .005 inches of the zero value. Reset the zero position of the capture bar per Appendix F if either deflection gage output is out of tolerance.
- 7.1.6. Repeat the previous two steps at the Test Engineer's direction to eliminate any initial non-linear response. Adjust the setup if any

problems arise during the loadings. Reset the zero position of the capture bar per Appendix F as required.

- 7.1.7. Repeat the previous 4 steps with the Bridge Pin, P/N SDG39135826-001, in hole set 1A of the vertex and the rear PAS Base Bridge Bracket, P/N SDG39135824-001. See Figure 7.1.7-1, 2, and 3 for pin location. When adjusting the location of the Bridge Pins, remove one Bridge Pin at one time. The Bridge Assembly, P/N SEG39135836-301, will need to be supported by hand during the relocation of the Bridge Pin. Secure the Bridge Pins with AN316C4R hex nut. If needed, use another AN316C4R hex nut as a jam nut to secure the Bridge Pins.

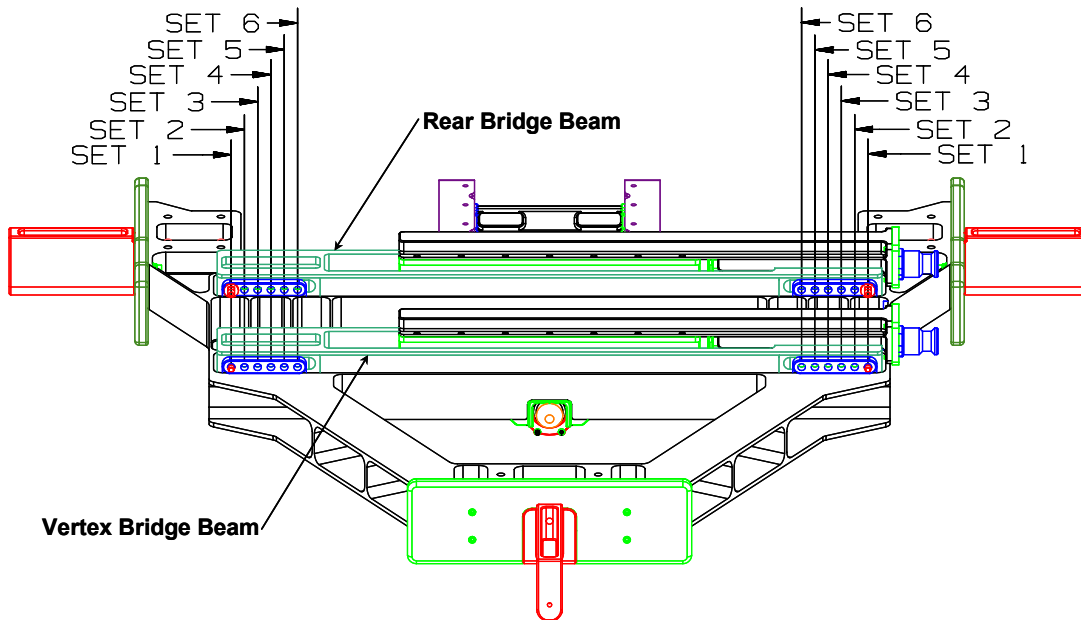


Figure 7.1.7-1: Pin Set Locations

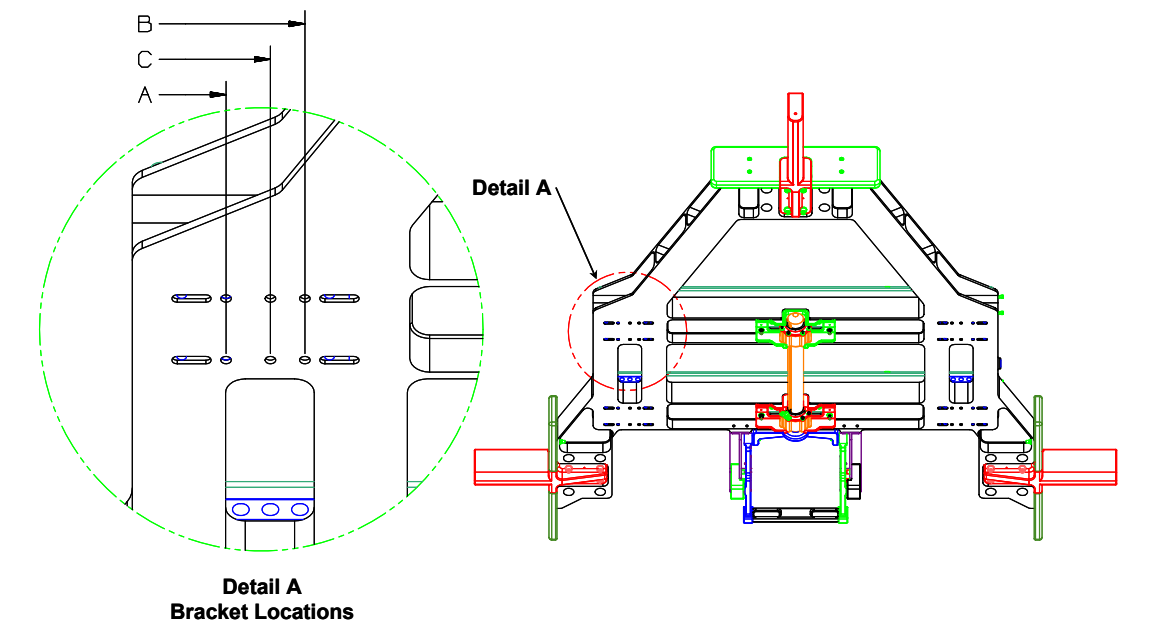


Figure 7.1.7-2: Bracket Set Locations

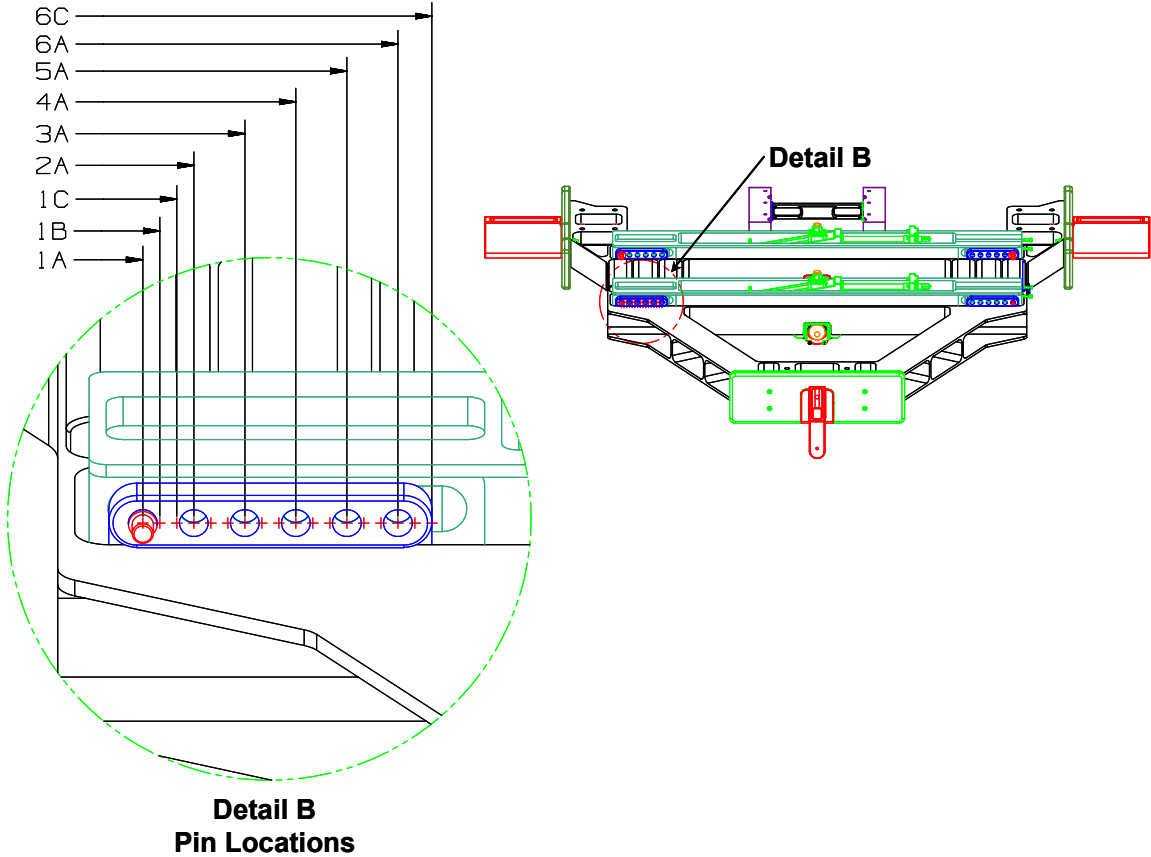


Figure 7.1.7-3: Stiffness Set Locations

7.2. Stiffness Set Procedure

- 7.2.1. Set the Bridge Pins, SDG39135826-001, on the PAS Base Bridge Bracket, P/N SDG39135824-001, in the hole location that sets the stiffness of the AMS-02 Passive PAS Assembly, P/N SEG39135815-301, near the required stiffness. Torque the nuts to hand tight.
- 7.2.2. Torque the Nut, P/N SDG36144420-001, on the Bearing, P/N 5310, to 2000 lbf (approximately 42 ft-lbs or 500 in-lbs) as indicated by the output of the load cell.
- 7.2.3. Record the value of deflection gage A at a load cell output of 2000 lbf. Determine the stiffness of the AMS-02 Passive PAS Assembly, P/N SEG39135815-301, based on the collected information.
- 7.2.4. If the stiffness of the AMS-02 Passive PAS Assembly, P/N SEG39135815-301 is above the upper limit of 14850 lbf/in, move the Bridge Pins, SDG39135826-001, to a numerically lower hole location. If the stiffness of the AMS-02 Passive PAS Assembly is below the lower limit of 12150 lbf/in, move the Bridge Pins to a numerically higher hole location. Adjust Bridge Pins until the stiffness of the AMS-02 Passive PAS Assembly is within the specified values. If necessary, the PAS Base Bridge Bracket, P/N SDG39135824-001, can also be adjusted individually to get the required stiffness. Adjust the PAS Base Bridge Bracket by loosening the fasteners that secure the base of the bracket to the AMS-02 Passive PAS Assembly. Remove only the middle fasteners. Shift the PAS Base Bridge Bracket inward or outward as required. Tighten the fasteners between 83 to 97 in-lbs. The running/locking torque shall be between 3.0 to 40 in-lbs.

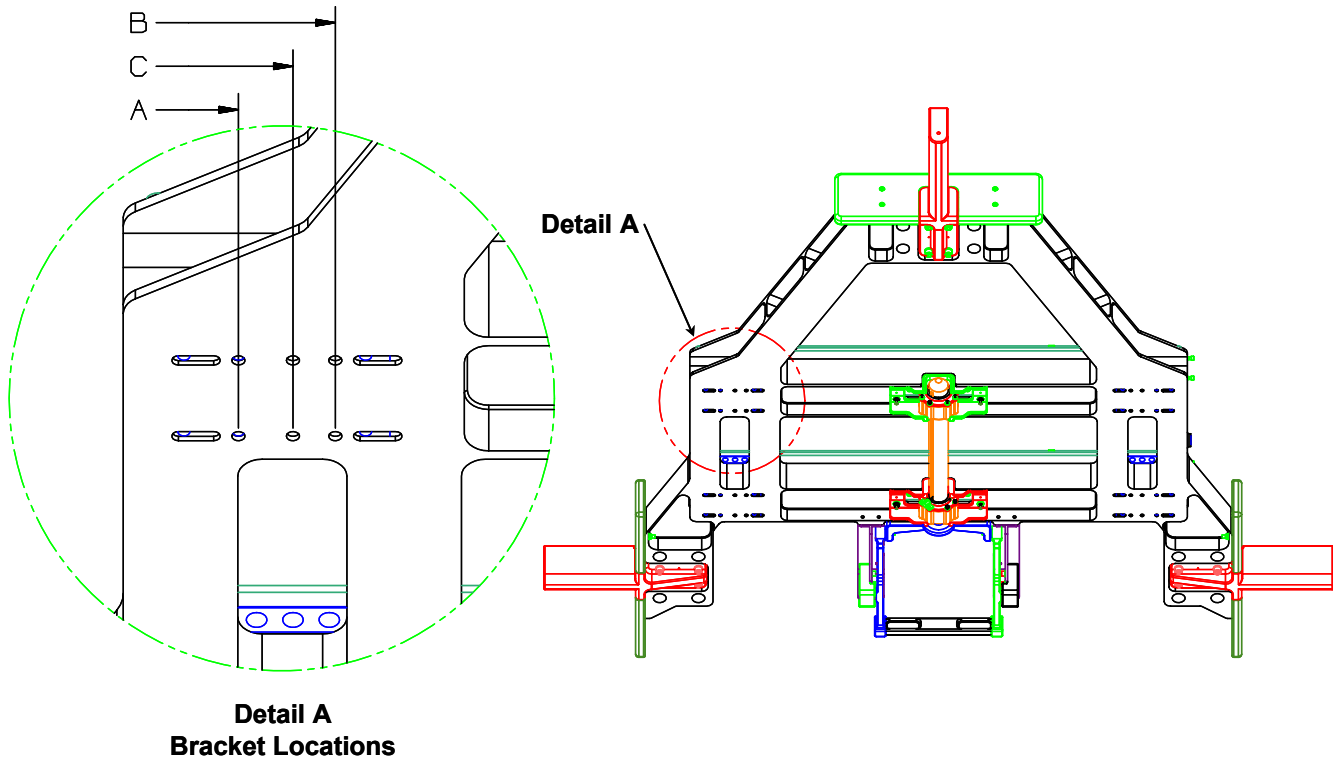


Figure 7.2.4-1: Bracket Adjustment

- 7.2.5. Once the AMS-02 Passive PAS Assembly, P/N SEG39135815-301, is within the specified stiffness values. Check the output of deflection gage B and C while the system is still loaded with 2000 lbf. The difference between output of B and C need to be less than .036 inches. If the difference between the gage B and C is greater than .036 inches, adjust the PAS Base Bridge Bracket, P/N SDG39135824-001 per previous step.
- 7.2.6. Recheck the stiffness of the AMS-02 Passive PAS Assembly, P/N SEG39135815-301, if the PAS Base Bridge Bracket, P/N SDG39135824-001, were adjusted in the previous step. Repeat the previous 2 steps to get the stiffness and the deflection within specified values.
- 7.2.7. Check the values of deflection gage B and C. Repeat step 7.2.5 if the values are out off tolerance.
- 7.2.8. When the stiffness and deflections are within the specified values, load the AMS-02 Passive PAS Assembly, P/N SEG39135815-301, to 2000 lbf (approximately 42 ft-lbs or 500 in-lbs) as indicated by the output of the load cell.

- 7.2.9. Record the output of deflection gage A and the load cell. Determine the stiffness of APAS Simulator Assembly, P/N SEG36144410-301, based of the output.
- 7.2.10. If the stiffness of the APAS Simulator Assembly, P/N SEG36144410-301, is above 24864 lbf/in move the Pivot Pins, P/N SDG36144415-001, outward. If the stiffness of the APAS Simulator Assembly is below 20989 lbf/in move the Pivot Pins inward.
- 7.2.11. Torque the Nut, P/N SDG36144420-001, on the Bearing, P/N 5310, to 6430 lbf (approximately 134 ft-lbs or 1608 in-lbs) as indicated by the output of the load cell
- 7.2.12. Lock the configuration in place by jamming the Hex Nut, P/N SDG36144427-003, if needed. Torque the top nut to 48 in-lbs above running/locking torque to lock the configuration.
- 7.2.13. Remove the capture bar per AMS-02 Passive PAS Assembly Capture Bar Removal procedure in appendix D.
- 7.2.14. Reinstall the capture bar per AMS-02 Passive PAS Assembly Capture Bar Installation procedure in appendix E.
- 7.2.15. Repeat Previous 3 Steps at the Test Engineer's direction.
- 7.2.16. Unload the test setup.
- 7.2.17. Disassemble the test hardware per Test Engineer's direction.

8.0 Pass/Fail Criteria

The criterion for a successful test is no permanent deformation of the Flight hardware and the successful unloading and removal of the capture bar.

9.0 Test Support

Personnel from the test facility will assist the Lockheed Martin personnel in test setup and test operations.

This test will involve Flight hardware and therefore, support from Quality Assurance personnel is required.

A Test Readiness Review will be conducted prior to the test to review procedures and provide approval to proceed. The test review board, as a minimum, will consist of the following personnel. Other personnel may be added as needed.

Table 9-1. Test Personnel

Responsibility	Representative	Contact
Test Engineer	Hsing Ju / LMSO	281-333-7494
Test Lead Engineer	Phil Mott / LMSO	281-333-6451
Project Manager	Kenneth Bollweg / LMSO	281-335-2714
Structural Lead	Trent Martin / LMSO	281-335-2139
Stress Lead	Chittur Balasubramanian / LMSO	281-333-7518
Stress Analyst	Howard Carter / LMSO	281-333-7339
PAS Design Engineer	Joe Kastelic / LMSO	281-333-7352
Dynamics Analyst	Chris Tutt / LMSO	281-333-7634
Safety	Facility Representative	-
Q.E.	Facility Representative	-
Instrumentation	Facility Representative	-
Chairperson	Facility Representative	-

Appendix A: Boeing Stiffness Analysis

FYI - here's the analysis

THANKS,
jjs

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e-mail: john.j.scheerer@boeing.com

> -----Original Message-----
> From: Simecka, Jay B
> Sent: Tuesday, November 20, 2001 2:59 PM
> To: Scheerer, John J
> Subject: CAS Interface
>
> <<CAS Interface.doc>>
> Jay Simecka
> Mechanical Strength
> X60699
>

CAS Interface Analysis:

Requirement of FEM analysis is that the interfaces could gap no more than .25 inches at ultimate loads and no gapping at 1.25 X limit loads.

Results of FEM analysis:

Active Half Stiffness: $K_a := 46858 \frac{\text{lbf}}{\text{in}}$ (+/- 12%) Nominal Preload: $F_{\text{preload}} := 5650 \text{ lbf}$

Minimum preload reqmt (from FEA):

Passive Half Stiffness: $K_p := 13500 \frac{\text{lbf}}{\text{in}}$ (+/- 12%) $F_{\text{min}} := 4900 \text{ lbf}$

Capture Latch Stiffness: $K_{\text{cla}} := 45000 \frac{\text{lbf}}{\text{in}}$ (+/- 5%)

Capture Latch Mounting Face to Capture Bar under 4700 lbf load Distance:
(per acceptance test)

$l_{\text{clapreload}} := 4.00 \text{ in}$ Tolerance: $t_{\text{cla4700}} := .018 \text{ in}$ total

Active platform tolerance due to final shimming: $t_{\text{platform}} := .005 \text{ in}$ total

Guide Vane Mounting Face to Guide Vane/pin interface Distance: $l_{\text{gv}} := 3.397 \text{ in}$

Pin Distance: $R_{\text{pin}} := 0.688 \text{ in}$ Tolerance: $t_{\text{gv}} := .010 \text{ in}$ total

Nominal Distance Between Capture Bar Centerline and Pin Centerline on Passive Half

Active Half Loaded Distance: $l_{\text{apreload}} := l_{\text{clapreload}} + \frac{F_{\text{preload}}}{K_a} - l_{\text{gv}} - R_{\text{pin}}$ $l_{\text{apreload}} = 0.036 \text{ in}$

Passive Half Unloaded Distance: $l_{\text{punloaded}} := \frac{F_{\text{preload}}}{K_p} + l_{\text{apreload}}$ $l_{\text{punloaded}} = 0.454 \text{ in}$

Tolerance on Passive Half: $t_{\text{passive}} := .010 \text{ in}$ total

Stiffness Range (includes thermal effects)

Nominal Stiffness: $K_{\text{nom}} := \frac{K_{\text{cla}} \cdot K_a \cdot K_p}{K_a \cdot K_p + K_{\text{cla}} \cdot K_p + K_{\text{cla}} \cdot K_a}$ $K_{\text{nom}} = 8500.7 \frac{\text{lbf}}{\text{in}}$

Max Stiffness: $K_{\text{max}} := \frac{1.05 \cdot K_{\text{cla}} \cdot 1.12 \cdot K_a \cdot 1.12 \cdot K_p}{1.12 \cdot K_a \cdot 1.12 \cdot K_p + 1.05 \cdot K_{\text{cla}} \cdot 1.12 \cdot K_p + 1.05 \cdot K_{\text{cla}} \cdot 1.12 \cdot K_a}$ $K_{\text{max}} = 9402.374 \frac{\text{lbf}}{\text{in}}$

CAS Interface Analysis:

$$\text{Min Stiffness: } K_{\min} := \frac{0.95 \cdot K_{\text{cla}} \cdot 0.88 \cdot K_a \cdot 0.88 \cdot K_p}{0.88 \cdot K_a \cdot 0.88 \cdot K_p + 0.95 \cdot K_{\text{cla}} \cdot 0.88 \cdot K_p + 0.95 \cdot K_{\text{cla}} \cdot 0.88 \cdot K_a} \quad K_{\min} = 7586.211 \frac{\text{lbf}}{\text{in}}$$

Tolerances and Thermal Ranges:

$$\text{Total Tolerance Range: } t_{\text{tol}} := \sqrt{t_{\text{passive}}^2 + t_{\text{cla4700}}^2 + t_{\text{gv}}^2 + t_{\text{platform}}^2} \quad t_{\text{tol}} = 0.023 \text{ in}$$

$$\text{Thermal Range: } \Delta t_{\text{h}} := 320 \text{ deg} \quad \alpha := .000013 \frac{\text{in}}{\text{in} \cdot \text{deg}}$$

$$\text{Thermal warping: } \Delta \kappa := .008 \text{ in}$$

$$t_{\text{thpreload}} := \Delta t_{\text{h}} \cdot \alpha \cdot \left(l_{\text{punloaded}} + \frac{F_{\text{preload}}}{K_a} - l_{\text{apreload}} \right) + \Delta \kappa$$

$$t_{\text{thpreload}} = 0.0102 \text{ in}$$

$$\text{Nominal total deflection: } \text{def}_{\text{nom}} := \frac{F_{\text{preload}}}{K_{\text{nom}}} \quad \text{def}_{\text{nom}} = 0.665 \text{ in}$$

$$\text{Maximum deflection: } \text{def}_{\text{max}} := \text{def}_{\text{nom}} + \frac{(t_{\text{tol}} + t_{\text{thpreload}})}{2} \quad \text{def}_{\text{max}} = 0.681 \text{ in}$$

$$\text{Minimum deflection: } \text{def}_{\text{min}} := \text{def}_{\text{nom}} - \frac{(t_{\text{tol}} + t_{\text{thpreload}})}{2} \quad \text{def}_{\text{min}} = 0.648 \text{ in}$$

Preload range:

$$\text{Maximum Preload: } F_{\text{maxp}} := K_{\text{max}} \cdot \text{def}_{\text{max}} \quad F_{\text{maxp}} = 6407.604 \text{ lbf}$$

$$\text{Minimum Preload: } F_{\text{minp}} := K_{\text{min}} \cdot \text{def}_{\text{min}} \quad F_{\text{minp}} = 4914.457 \text{ lbf}$$

Appendix B: Lift Plan for Lower USS Simulator Assembly

1. The Lower USS Simulator Assembly, P/N SEG36144421-301, weighs about 100 lbs. The lift will require three people.
2. Two people should stand at the corners of the Lower USS Simulator Assembly, P/N SEG36144421-301, near the Rear Bracket Simulators, P/N SEG36144425-301. The remaining person should stand where the Vertex Bracket Simulator, P/N SEG36144425-303, is located. See Figure B-1.
3. Lift the Lower USS Simulator Assembly, P/N SEG36144421-301, out of its shipping container. The lift should be coordinate among the people involved. The lift should be performed per lifting training provided by Lockheed Martin.

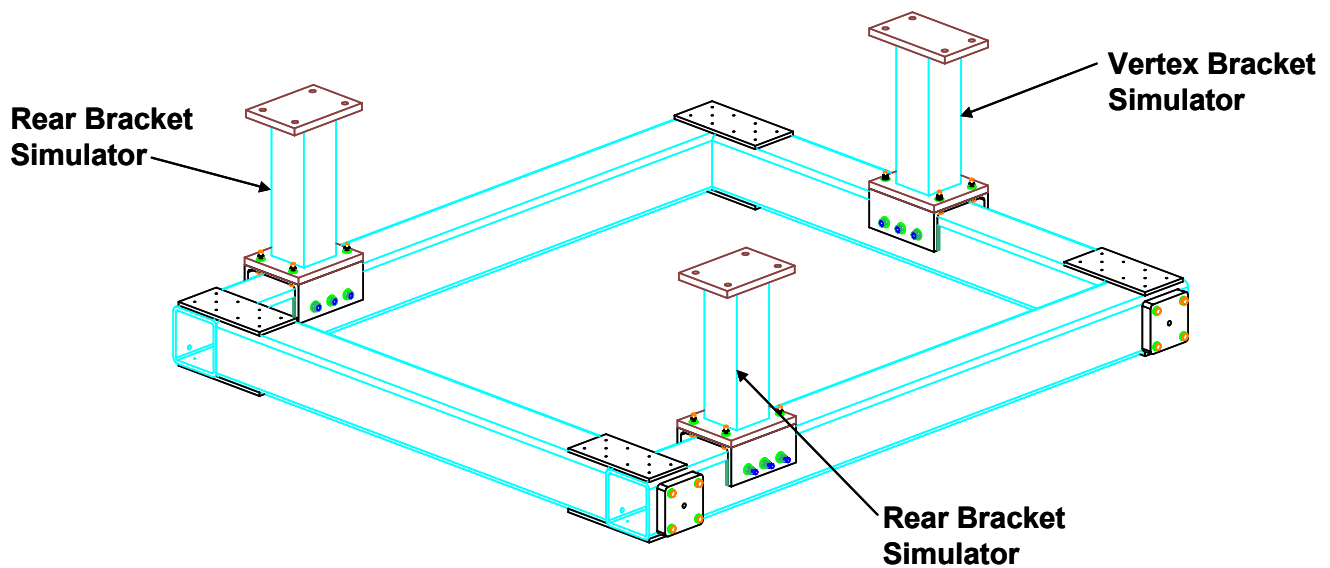


Figure B-1: Lower USS Simulator Assembly

Appendix C: Lift Plan for AMS-02 Passive PAS Assembly

1. The AMS-02 Passive PAS Assembly, P/N SEG39135815-301, weighs about 170 lbs. The lift will require at least four people.
2. One person should stand at each of the rear guide pins of the AMS-02 Passive PAS Assembly, P/N SEG39135815-301. The remaining two people should stand at the legs of the AMS-02 Passive PAS Assembly, P/N SEG39135815-301. See Figure C-1.
3. Lift the Lower USS Simulator Assembly, P/N SEG36144421-301, out of its shipping container. The lift should be coordinated among the people involved. The lift should be performed per lifting training provided by Lockheed Martin.

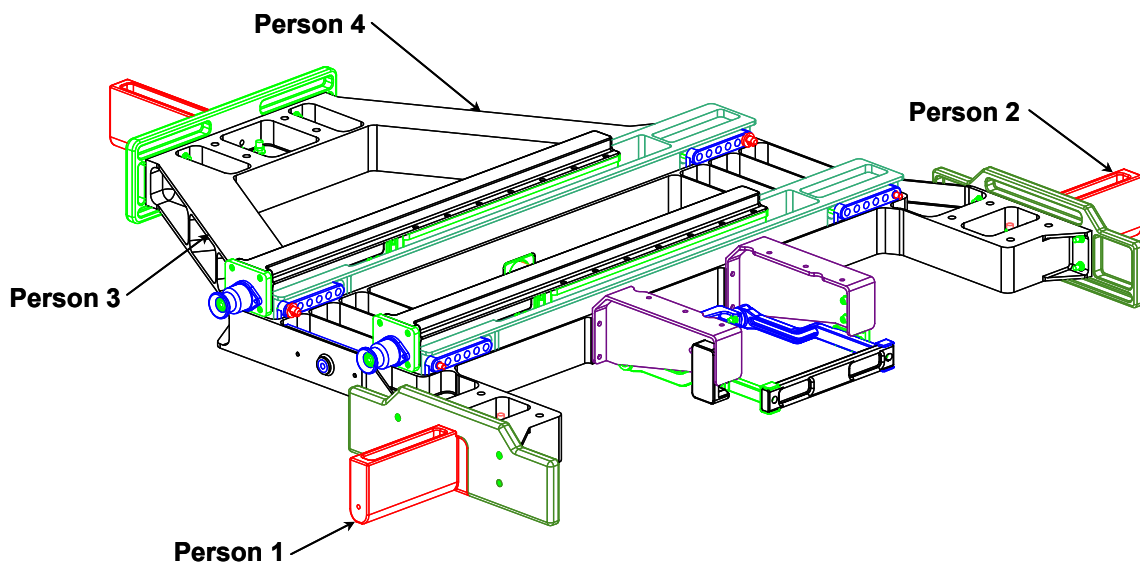


Figure C-1: Lower USS Simulator Assembly

Appendix D: AMS-02 Passive PAS Assembly Capture Bar Removal Procedure

DO NOT use **POWER TOOLS** for this procedure

1. Insert a 7/16 internal hex drive into the EVA Extension Locking Mechanism, P/N SEG39136828. The EVA Extension Locking Mechanism is a part of the Load Release Screw 1 and 2. See Figure D-1. Depress the locking mechanism retractor a minimum of .375 inches or until bottomed out.
2. The Load Release Screws are turned in stages. Turn the Load Release Screw with the 7/16 internal hex drive **CLOCKWISE**. The amount of turns for Load Release Screw 1 and 2 shall be the same. Turn Load Release Screw 1 no more than 20 turns then alternate and turn Load Release Screw 2 no more than 20 turns. Alternate back and forth between the screws in increments not greater than 20 turns. Stop turning the Load Release Screws when there is a significant rise in the running/locking torque from both EVA nuts. Estimated number of turns for each screw is 80 to 100 full revolutions.
3. Pull on the capture bar axially until the retainer mechanism restricts further movement.

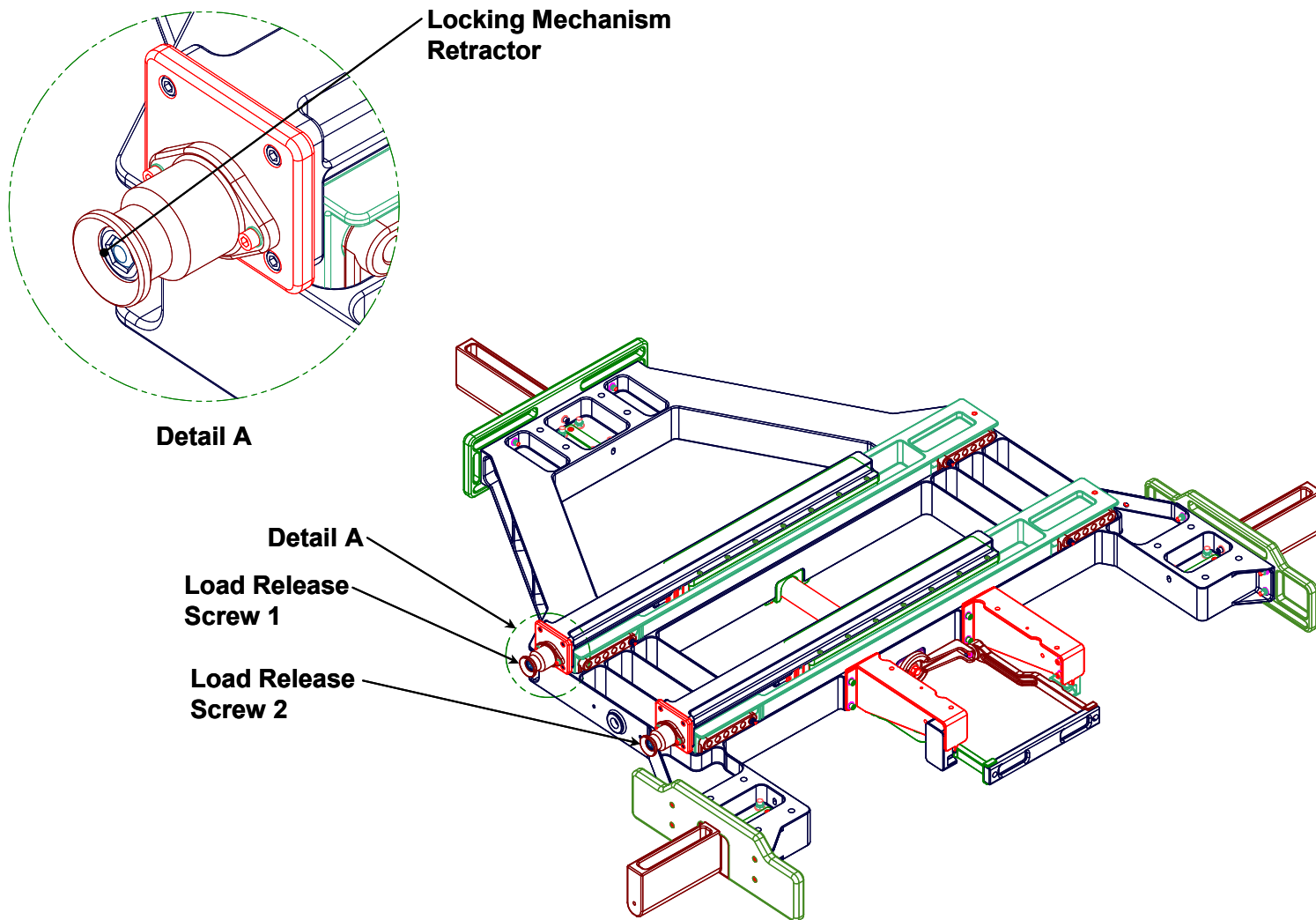


Figure D-1: Load Release Screw

Appendix E: AMS-02 Passive PAS Assembly Capture Bar Installation Procedure

DO NOT use **POWER TOOLS** for this procedure

1. Prior to turning the Load Release Screws, the capture bar shall be fully mated and supported by both bearing assemblies. The Capture Bar Base, the end with the handle, shall have surface contact with the Aft Capture Bar Retainer Bracket. See Figure E-1.
2. Insert a 7/16 internal hex drive into the EVA Extension Locking Mechanism, P/N SEG39136828. The EVA Extension Locking Mechanism is a part of the Load Release Screw 1 and 2. See Figure E-2. Depress the locking mechanism retractor a minimum of .375 inches or until bottomed out.
3. The Load Release Screws are turned in stages. Turn the Load Release Screw with the 7/16 internal hex drive **COUNTER CLOCKWISE**. The amount of turns for Load Release Screw 1 and 2 shall be the same. Turn Load Release Screw 1 no more than 20 turns then alternate and turn Load Release Screw 2 no more than 20 turns. Alternate back and forth between the screws in increments not greater than 20 turns. Stop turning the Load Release Screws when there is a significant rise in the running/locking torque from both EVA nuts. Estimated number of turns for each screw is 80 to 100 full revolutions. See Figure E-2

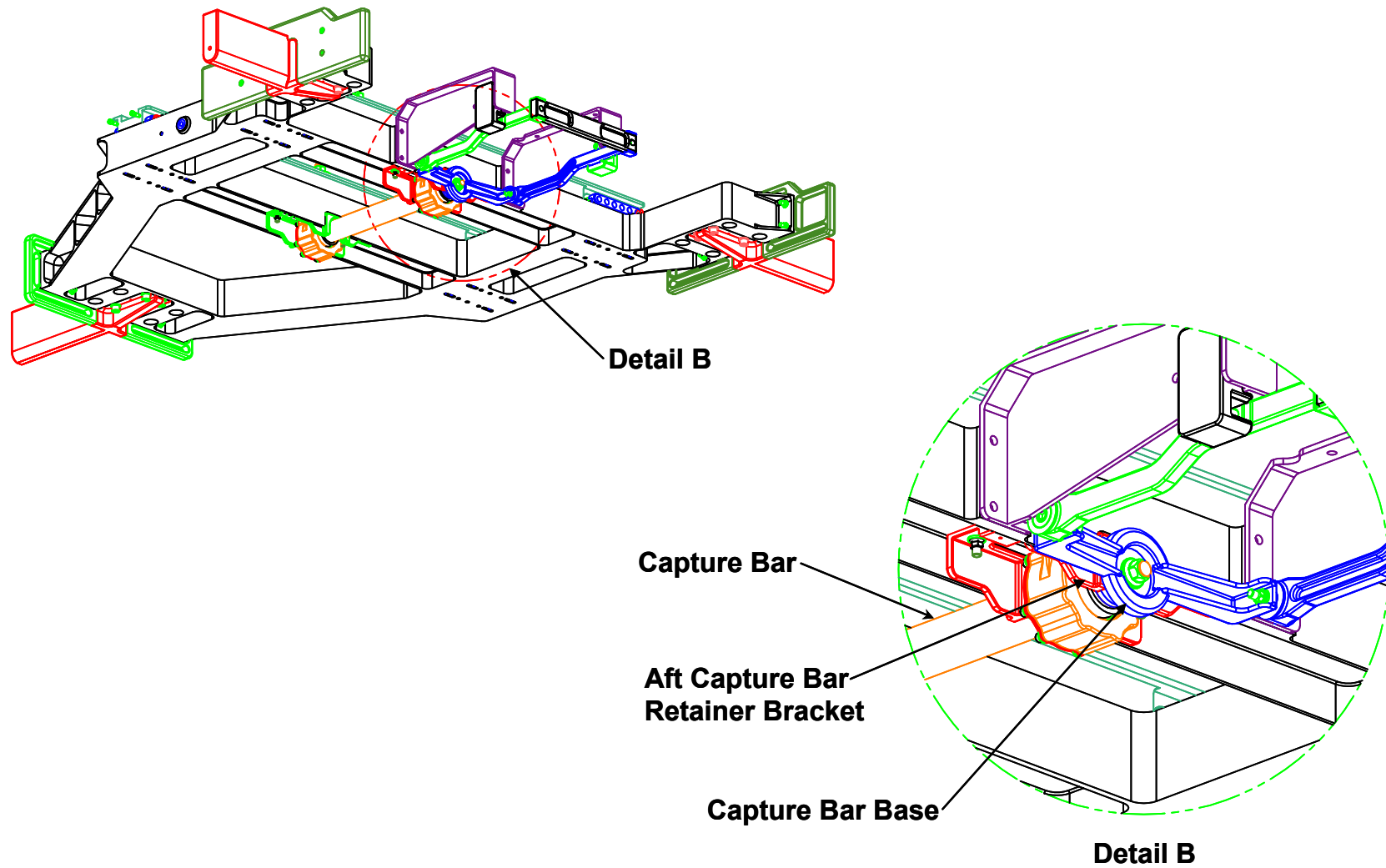


Figure E-1: Capture Bar Installation

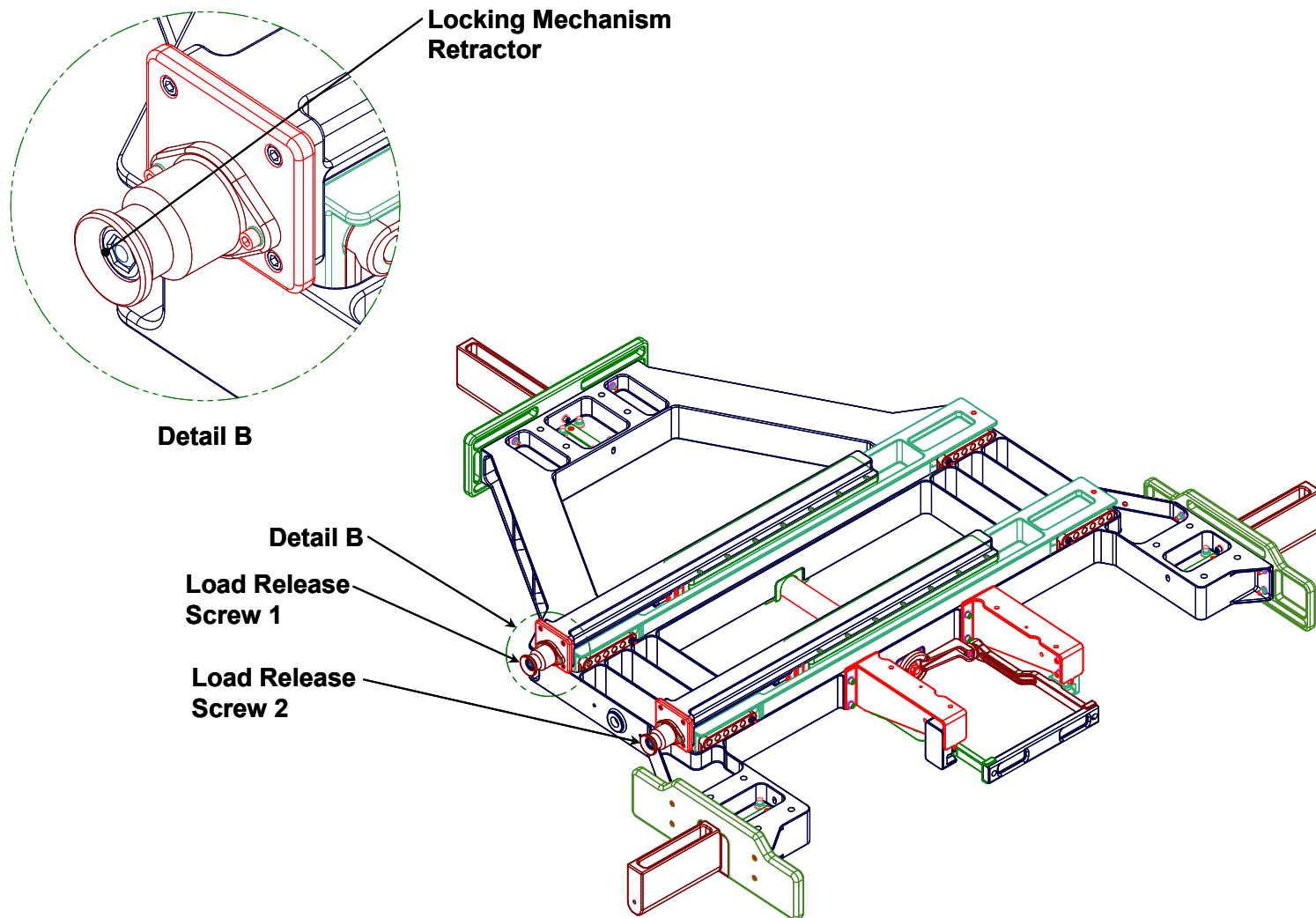


Figure E-2: Load Release Screw

Appendix F: AMS-02 Passive PAS Assembly Capture Bar Reset Procedure

DO NOT use **POWER TOOLS** for this procedure

Engage the EVA Release Mechanism screw using a 7/16 internal hex socket.

The EVA extension Locking Mechanism shall be depressed a minimum of .375.

Proper engagement shall deflect the locking mechanism to the solid or “bottomed out” condition. Advance the EVA screw until the deflection gage reads zero. A noticeable and sharp increase in torque should be expected.

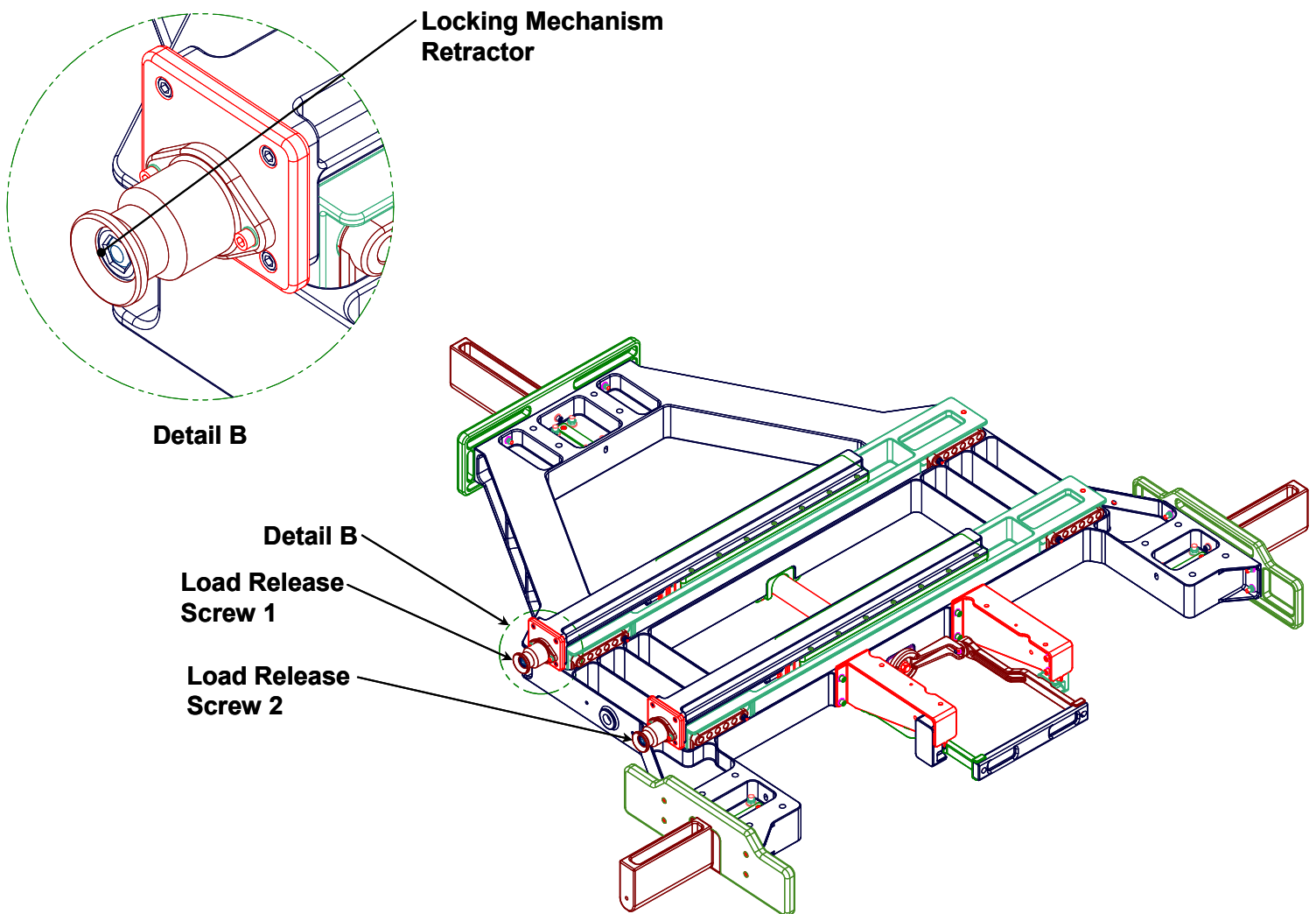


Figure F-2: Load Release Screw